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Scallop Fishing Area 29: Stock Status and Update for 2013

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

This scallop fishery has taken place in the portion of Scallop Fishing Area (SFA) 29 west of longitude 65°30′ W since 2001 and is currently conducted by two fleets: the Full Bay Fleet and a limited number of inshore East of Baccaro licence holders. As of 2010, the Total Allowable Catch (TAC) and landings are reported for both fleets combined. In 2012, a total of 167.2 t was landed against the TAC of 160 t. There was an additional Food, Social and Ceremonial catch of 4.7 t. From 2011 to 2012, catch rates declined or stayed the same in subareas A, C, D and E, but increased by over 40% in subarea B. In 2012, there was an increase in the mean number of commercial scallops in the survey for subareas A, B, and D, and no change in C. The number of recruit size scallops per tow increased in subareas A, B, and C, but did not change in D. Pre-recruits showed an increase in all subareas. The mean weight per tow and survey biomass increased in subareas A to D from 2011 to 2012. Condition factors increased in subareas A to D, but the increase was less dramatic in subarea D. Some of the highest growth rates for SFA 29 West were observed in 2012, particularly in subarea B. Two methods were used to estimate exploitation rates in SFA 29 West: one from commercial catch rates, representing more localized conditions, and one from the research survey, representing broader conditions. Trends in annual total fishing effort (hours fished) were also presented since effort is assumed to be directly related to fishing mortality. From 2011 to 2012, effort decreased in subareas A and D by 94 and 48%, respectively, while smaller decreases in effort were recorded for subareas B (10%) and C (12%). Exploitation estimates generally indicated a decrease in all subareas in 2012. A total TAC similar to that in 2012 is recommended. A reduction in TAC in subarea C would promote recovery of this area, and an increase in TAC in subarea B would be consistent with the observed increase in abundance and biomass in this area. The estimated number of lobster caught represents 0.01% of the lobsters caught in the 2011/2012 Lobster Fishing Area (LFA) 34 lobster fishery and 0.05% of the lobsters caught in the area of LFA 34 corresponding to SFA 29 West. In 2012, it is estimated that 4,302 lobsters were caught during the SFA 29 West scallop fishery; 940 were dead or injured.

Zone de pêche 29 du pétoncle: état du stock et mise à jour pour 2013

RÉSUMÉ

La pêche du pétoncle considérée ici se déroule dans la partie de la zone de pêche du pétoncle (ZPP) 29 située à l'ouest de la longitude 65° 30' O depuis 2001; elle est actuellement pratiquée par deux flottilles, soit la flottille de la totalité de la baie et un nombre limité de titulaires de permis de pêche côtière pour l'est de Baccaro. Depuis 2010, le total autorisé des captures (TAC) et les débarquements sont totalisés pour l'ensemble des deux flottilles. En 2012, les débarquements totaux se sont chiffrés à 167,2 t, par rapport à un TAC de 160 t. De plus, les captures à des fins alimentaires, sociales et rituelles se sont chiffrées à 4,7 t. Entre 2011 et 2012, les taux de captures ont diminué ou sont demeurés les mêmes dans les sous-zones A, C, D et E, mais ils ont augmenté de plus de 40 % dans la sous-zone B. En 2012, le nombre moyen de pétoncles de taille commerciale a augmenté dans le relevé pour les sous-zones A, B et D, mais il n'a pas changé dans la sous-zone C. Le nombre de recrues par trait a augmenté dans les sous-zones A, B et C, mais il n'a pas changé dans la sous-zone D. Le nombre de pré-recrues a augmenté dans toutes les sous-zones. Entre 2011 et 2012, le poids moyen par trait et la biomasse dans les relevés ont augmenté dans les sous-zones A à D. Les coefficients de condition ont augmenté dans les sous-zones A à D, mais l'augmentation était moins importante dans la sous-zone D. Certains des taux de croissance les plus élevés pour la ZPP 29 ouest ont été observés en 2012, en particulier dans la sous-zone B. Deux méthodes ont été utilisées pour estimer les taux d'exploitation dans la ZPP 29 ouest : l'une fondée sur les taux de captures commerciales, représentant plutôt les conditions locales, l'autre fondée sur le relevé de recherche, représentant les conditions plus générales. Les tendances de l'effort de pêche annuel (heures de pêche) ont également été présentées puisqu'on présume que l'effort est directement lié à la mortalité par pêche. Entre 2011 et 2012, l'effort dans les sous-zones A et D a diminué de 94 % et 48 %, respectivement, tandis que des diminutions moins importantes de l'effort ont été enregistrées pour les sous-zones B (10 %) et C (12 %). En général, les estimations du taux d'exploitation indiquent une diminution dans toutes les sous-zones en 2012. Un TAC semblable à celui pour 2012 est recommandé. Une réduction du TAC dans la sous-zone C favoriserait le rétablissement dans celle-ci, tandis qu'une augmentation du TAC dans la sous-zone B correspondrait à l'augmentation de l'abondance et de la biomasse observée dans cette sous-zone. Le nombre estimé de homards capturés représente 0,01 % des homards capturés pendant la pêche du homard dans la zone de pêche du homard (ZPH) 34 en 2011-2012 et 0,05 % des homards capturés dans la ZPH 34 qui correspond à la ZPP 29 ouest. Il est estimé qu'en 2012, 4 302 homards ont été capturés pendant la pêche du pétoncle dans la ZPP 29 ouest; 940 étaient morts ou blessés.

INTRODUCTION

Scallop Fishing Area (SFA) 29 encompasses a very large inshore area inside the 12-mile territorial sea, from the south of Yarmouth (latitude 43°40'N) to Cape North in Cape Breton (Figure 1). This report refers to only that portion of SFA 29 west of longitude 65°30'W continuing north to Scallop Production Area 3 at latitude 43°40'N (hereafter referred to as SFA 29 West). This area is fished by the Full Bay fleet and inshore East of Baccaro licence holders who are authorized to fish in SFA 29 West.

The history of fishing in this area up to 2001 can be found in Smith and Lundy (2002). A review of the three-year joint project agreement signed in 2002 with the two fishing fleets, Natural Resources Canada, and Department of Fisheries and Oceans (DFO) with all parties providing funds to conduct multi-beam acoustic mapping of the seafloor and other scientific work was reported in DFO (2006).

This report summarizes commercial fishery, research survey, and observer data for the 2012 fishery and provides advice for the 2013 fishery. As in previous documents, details on lobster bycatch are provided. The scallop fishery in this area was last assessed in 2012 (Sameoto et al. 2012) including information on the bycatch of other species in addition to lobster.

COMMERCIAL FISHERY

The fishery management plan sets a 100 mm minimum shell height for retained scallops. In this report, scallops with shell height 100 mm and greater will be referred to as fully-recruited or commercial size and 90–99 mm scallops will be referred to as recruits and are expected to grow to be commercial size in the following year.

The 2012 fishery opened on June 25, 2012, with a total quota of 160 t allocated over subareas A B, C, D and E (Table 1). Subareas B and D were closed on July 9 and July 10, respectively, as the quota had been caught or exceeded in those two subareas. As of the July 26 quota report, there was only 10.7 t remaining out of the total quota and the remaining areas were closed on August 6, 2012. This closure left a number of fishers with uncaught quota, and the Minister directed the fishery to re-open from August 30 to September 15 to allow those fishers with uncaught quota to catch up to 75% of their remaining share. All subareas were available to be fished for the re-opening. The final total catch was 171.9 t and included 4.7 t of Food, Social, and Ceremonial (FSC) catch that does not count against the Total Allowable Catch (TAC). There were no closed areas in 2012 as a result of lobster bycatch.

COMMERCIAL CATCH RATE

ANNUAL TRENDS

Subarea A has been fished sporadically by the East of Baccaro fleet and more consistently by the Full Bay fleet. From 2011 to 2012, catch rates in this subarea declined by 14% and 39% for Full Bay and East of Baccaro fleets, respectively (Figure 2). The greatest increases in catch rates were in subarea B for both fleets. Catch rates in this subarea were stable for both fleets from 2007 until 2009, declining in 2010. From 2011 to 2012, catch rates increased by over 40% for both fleets (Figure 2). In subarea C, catch rates for both fleets showed almost no change. The catch rates of the two fleets have been very similar in this area, with both showing generally declining catch rates since 2007–2008 (Figure 2). Catch rates in subarea D have declined since 2005. In 2012, the Full Bay fleet catch rate in subarea D did not change, while the East of Baccaro catch rate declined by 16% (Figure 2). Subarea E is subject to sporadic fishing. The catch rate for Full Bay in subarea E declined from 2009 to 2011, and increased by 34% in 2012.

In contrast, the East of Baccaro catch rate in this subarea has been slowly declining since 2008 and in 2012 decreased 14% from 2011 to 2012 (Figure 2).

The area covered by the fishery changed between 2011 and 2012, most notably in subareas A and D (Figure 3). In 2011, fishing in subarea A occurred in about two thirds of the subarea; in 2012, fishing was greatly reduced, and the catch rates were in the range of 5-20 kg/h (Figure 3). The fishery in subarea D covered less area in 2012 relative to 2011, while fishing was well-distributed over most of C in both years. Fishing in subarea B was more focused in 2012, and catch rates were generally higher over the area fished than in 2011. Fishing in subarea E was mainly located along the border with subarea B in 2012 (Figure 3).

RESEARCH SURVEY

Annual surveys in SFA 29 West have been conducted since the start of the current fishery in 2001. The initial survey in 2001 used a simple random design over the whole area. From 2002 to 2004, a stratified random design was used with strata defined by the management subareas A to E. Starting in 2005, strata were defined by bottom type as identified by geologists as part of the joint industry/government multibeam mapping project conducted in this area (DFO 2006). A new interpretation of the bottom types was made available in 2008 (Todd et al. 2009) and was used to design the surveys for 2008 through 2012. Survey estimates from 2001 to 2007 were modified to correspond to this new design. Subarea E has not been consistently covered in the survey due to time limitations; this subarea is considered to be marginal habitat for scallops and, as a result, has been less of a survey priority. The survey occurs in September/October after the fishery has closed.

From 2001 to 2004, the survey was conducted in all subareas by a Full Bay fleet vessel. From 2005 to 2011, surveys were conducted by both Full Bay and East of Baccaro vessels. The Full Bay fleet vessel surveyed all subareas, and the East of Baccaro vessel surveyed subareas C and D. In 2012, the survey was conducted in full by one vessel, fishing vessel (F/V) *Hit `N' Miss*, due to changes in contracting and funding arrangements.

Recent experience with comparative surveys between different vessels and different gears (9-gang miracle gear and 4-gang Digby gear) in the Bay of Fundy survey had demonstrated that once the catches had been corrected for area towed there was no evidence of significant differences between the catches from the two different vessel/gear combinations (Smith et al. 2012a). In the case of the change of vessels between the 2011 and 2012 survey in SFA 29, the same gear was used and a comparative study was not considered necessary given the Bay of Fundy results.

In recent years, this survey was funded through the Larocque Relief Fund program which ended in 2012. Discussions have been initiated with the fishing industry to establish an alternate funding arrangement for supporting the surveys in 2013 and future years.

ABUNDANCE INDICES

Stratified mean number and weights of meats per tow were calculated within subarea using strata based on geophysical bottom types (Todd et al. 2009). The efficiency of the current design and the methods used to convert estimates from previous surveys were examined previously in Smith et al. (2009a and 2009b).

In 2011, there was an increase in the numbers of recruit size scallops (90–99 mm shell height) in subarea A; in 2012, the number of recruit scallops increased again (Figure 4). There was also an increase in commercial size scallops (>100 mm) since 2011 (Figure 4). The mode in this area is around 130–135 mm, but there were greater numbers of smaller commercial scallop (100–115 mm) than has been found in this area for a few years (Figure 5). Weight per tow and

survey biomass in this subarea increased for both recruit and commercial size scallops since 2011 and are around 2010 levels for commercial size scallops (figures 6 and 7).

The greatest increase in numbers was seen in subarea B (Figure 4), where the numbers of commercial scallop almost tripled from 2011 values. The shell height frequencies show a shift to smaller commercial size scallops than in previous years in this area. This subarea has the smallest mode for commercial scallops at 105–110 mm (Figure 8). Survey biomass and weight per tow in the survey in this subarea increased greatly as well, with commercial scallops increasing from 1.3 kg/tow in 2011 to 3.8 kg/tow in 2012 (Figure 6).

In subarea C, there has been little change in the number of commercial scallops per tow since 2010 (Figure 4). In 2012, there was a small increase in weight per tow and survey biomass of commercial scallop, likely due to increased condition in the area (figures 6 and 7). Recruit numbers and weight per tow increased in 2012 after decreasing in 2011 and are similar to 2010 values (figures 4 and 6). The shell height frequency shows more pre-recruit (<90 mm) scallop in this area than has been observed since 2007 (Figure 9).

There was no change in the number of recruit size scallops in subarea D in 2012, but the biomass of recruit scallops increased (figures 4 and 7). Both the number per tow and biomass of commercial scallop has increased since 2011. There was evidence of an abundance of small scallop (<45 mm) in this area, but this size range is at the limit (38 mm) of the survey gear (Figure 10).

Until this year, subarea E had not been included in the survey since 2005. In 2012, five tows were completed in locations based on the Vessel Monitoring System (VMS) data from the 2012 fishery. The mean number of commercial scallops in subarea E was 217 scallops/tow, which was comparable to the mean in subarea B. The mean number of recruits was 21 scallops/tow. The weight per tow in subarea E was also comparable to other areas, at 2.9 kg/tow and 0.27 kg/tow for commercial and recruit scallops, respectively. The shell height frequency for this subarea in 2012 (Figure 11) shows the presence of prerecruits, and the most abundant commercial scallop are between 100–120 mm.

The mean number of clappers (paired empty shells used as indicators of natural mortality) in the survey has been low with little variation for the last four to six years of the survey (Figure 12). In 2012, there were slight increases in the number of clappers per tow in subareas A and B. Shell height frequencies for clappers from the surveys are presented in figures 13 to 16. Clappers were observed in subarea E at very low levels in 2012 (less than 1 per tow), and no recruit size clappers were observed.

GROWTH AND CONDITION

In those scallop fishing areas in the Maritimes Region where assessment models are used, biomass growth is an important component of the population model. In recent assessments, there have been some modifications made that take into account the annual variations in the condition of scallop meats. Previously, biomass growth was assumed to vary based on the mean meat weight of the commercial size animals such that the annual growth increment will decrease (increase) as the average mean meat weight increases (decreases) representing an older slower growing (younger, faster growing) population. This assumes that mean meat weight of the commercial size animals is a proxy of the mean shell height. However, in many areas the relationship between meat weight and shell height (condition) has shown a great deal of spatial and temporal variability that has complicated the fit of these models (Sameoto et al. 2012, Nasmith et al. 2013). In this assessment, spatial patterns of growth and condition were examined and, in the case of condition, incorporated into the estimates of survey biomass.

Condition factor was calculated from shell height and meat weight data collected on the survey for each tow sampled for detailed measurements, then predicted for tows that were not sampled

for meat weights, based on year, depth and location using a generalized additive model, see Sameoto et al. (2012) for a detailed description of the methods.

The annual component of this model indicates that condition has increased sharply in the last year over all of SFA 29 West after declining for two years previously (Figure 17). When the annual component is broken down by subarea, it appears that the increase occurred over all subareas but was less dramatic in subarea D (Figure 18).

Similar trends in condition were reported for the Bay of Fundy scallop production areas in 2012 along with the observation that temperatures throughout the water column had also increased from 2011 to 2012 (Nasmith et al. 2013). Cranford et al. (1998) reported that despite evidence for high correlations between scallop growth rates and temperature, laboratory experiments suggested that sea scallop growth may be independent of temperature if sufficient food is available. However, the increased temperatures may have second order effects by promoting higher growth rates and production of the phytoplankton that the scallops feed upon.

In 2012, condition tended to be higher in subarea C and the northern half of D, variable in B with the lowest condition throughout in A (Figure 19). It is important to consider spatial abundance patterns when placing spatial condition patterns in context. Abundance, in addition to being generally low, is also fairly patchy in SFA 29 West. Areas with relatively high abundance (≥ 100 scallops per tow) can be found in the central part of D and throughout B with a few patches of very high abundance (≥ 500 scallops per tow) (Figure 20). Recruits (are generally sparse with a few patches in A and B and there were almost no recruits in C or D (Figure 21). The combination of spatial patterns of condition and abundance can be used to predict the spatial distribution of meat count. The predicted meat count for SFA 29 West was generally low, mainly below 20 meats/500 g in subareas C and D and below 30 meats/500 g in subareas A and B. Low meat counts here are due to a combination of factors including the fact that the commercial size class consists mainly of large scallops with fewer small scallops, as well as the overall increased condition factor (Figure 22). Low meat counts reflect the higher condition as well as the fact that in 2012 the commercial size scallops were mainly comprised of larger scallops.

Annually varying growth rates for the biomass of the commercial size scallops were calculated using a von Bertalanffy growth equation for shell growth and the change in condition factor from year to year (Sameoto et al. 2012). The resulting annual observed growth factor was much more variable than the theoretical growth factor which varies only with respect to average weight (Figure 23). It is also important to note that occasionally the growth factor is near, at, or below 1 which would indicate zero growth. This situation was observed in subarea C and D in 2011, where there was an overall decline in condition from 2010 to 2011. The overall increase in condition from 2011 to 2012 corresponded to some of the highest growth rates observed in the time series (Figure 23).

EXPLOITATION ESTIMATES

DEPLETION ESTIMATES

In previous assessments (e.g., Sameoto et al. 2012), annual exploitation rates were estimated in subareas A to D using the depletion model described by Leslie and Davis (1939). In Smith et al. (2010), the depletion model was cast as a hierarchical Bayesian model (HBM) that shared information across years in order to mitigate issues that arise when there is insufficient data to show a distinct decline of catch rates in response to removals. The information shared was with respect to the catchability coefficient and the model was fit to the daily catch rates and incorporated standard errors derived from jackknife estimates (Sameoto et al. 2012).

The HBM was fit to the fishery data for subarea A from 2004–2012 (Figure 24), subarea B from 2003–2012 (Figure 25), subarea C from 2002–2012 (Figure 26), and subarea D from 2004–

2012 (Figure 27). The fishery in subarea A has been sporadic over time and, for some years, including 2012, was only fished for a few days (Figure 24). As a result there were limited fishery data from which to construct depletion estimates. This lack of data produced results with a very high degree of uncertainty and the results are not presented here.

Subarea B is a large area that has presented difficulties when attempting to estimate exploitation for past years due to the fishing pattern (Smith et al. 2009b). In most cases a gradual decline in catch rate was observed over the course of the fishery except for 2003, 2005, 2010 and 2012 where a steep decline was observed (Figure 25). As with the HBM fit in Smith et al. (2010) data from 2002 was not included but, as data from the last two years were added, the informative hyperprior was no longer necessary. The estimates for q tended to a low mean and moderate variance with higher q in 2003, 2005, 2010 and 2012 which may reflect a more concentrated fishery (Figure 28). Estimates of the annual pre-fishery biomass have been highly variable over time and may be the result of differences in the areas being fished from season to season. There is a declining trend from a median biomass of 610 t (95% credible bounds of 354 and 1959) in 2006 to 169 t (95% credible bounds of 132 and 258) in 2012 (Figure 29). Estimates of exploitation alternate between relatively low years (0.14 to 0.24) in 2004, 2006–2009 and 2011 to relatively high years (0.43 to 0.57) in 2003, 2005, 2010 and 2012 (Figure 30). Subarea B is the only area that saw an increase in exploitation in 2012 and that increase was concurrent with an increase in catch over the TAC limit.

The consistent depletion effect in subarea C results in reasonable estimates of initial biomass and exploitation (Figs. 26, 28, 29 and 30). The very high rate of depletion that occurred in 2002 resulted in estimates of pre-fishery biomass (565 t) and exploitation (0.77) similar to the results reported in Smith et al. (2009b). The pre-fishery biomass declined sharply at first to 265 t prior to the 2003 fishery and has declined gradually since 2004 (Figure 29). The estimate of pre-fishery biomass in 2012 was unchanged from 2011 at 130 t (95% credible bounds of 100 and 189, Figure 29). Since 2003 the exploitation rate in subarea C has been relatively high ranging from 0.28 to 0.51 (Figure 30). The exploitation rate for 2012 was estimated to be 0.30.

Subarea D only partially opened in 2004 and initially very high catch rates were observed in a small concentrated area. These rates declined sharply throughout the season that year which led to an estimate of q of 0.56 in 2004, while the mean of the prior was only 0.17 (Figure 28). As a result, the biomass pre-fishery 2004 was estimated at only 234 t and the exploitation was 0.81. Pre-fishery biomass was estimated to be greater (632 t) in 2005 when the entire area was opened but has since declined to 140 t (95% credible bounds of 75 and 493) in 2012 (Figure 29). Exploitation decreased sharply from 2004 (0.8) to 2005 (0.12), increased in 2006 (0.31), decreased again in 2007 (0.17), increased gradually from 2007 to 2010 (0.41), and has since declined to 0.23 in 2012 (Figure 30).

Scallops are a nearly sessile organism and therefore depletion estimates only apply to the area targeted by the fishery. Fishing patterns are often concentrated in certain high density areas so that depletion estimates may be indicative of local conditions rather than the entire subarea (Smith et al. 2008). There appeared to be a correlation between estimated initial biomass and the area fished as determined from VMS records (Smith et al. 2009b). The lower estimated biomass for D in 2004 appears to reflect the smaller areas being fished.

SURVEY MODEL

Exploitation and total mortality estimates calculated from the annual trends in survey biomass have been presented in previous assessments of SFA 29 West (Smith et al. 2010, Sameoto et al. 2012). A simplified version of the biomass dynamic model used in other scallop areas in the region was fitted to the survey biomass estimates to determine annual changes in biomass after accounting for somatic growth and recruitment (Trenkel 2008, Mesnil et al. 2009, Smith et al. 2012b).

As in Sameoto et al. (2012), estimates of somatic growth by subarea were obtained from the growth model presented above (Figure 23), while natural and fishing mortality were left as a single combined term reflecting total mortality but referred to as exploitation for our purposes here. The posterior distribution was simulated using WinBugs (Lunn et al. 2013) with two chains of 20,000 iterations each and a burn-in of 10,000 iterations. Convergence to the posterior was checked using the Brooks-Gelman-Rubin method (Brooks and Gelman 1998).

The fit of the models to the survey biomass indices for each subarea differed little from last year's results (Figure 31). In subarea B, the fitted value for 2012 lay below the observed biomass estimate despite the high growth rate estimated there, indicating that the increase observed for the 2012 survey biomass was greater than expected given our assumptions about the population dynamics for scallops.

COMPARING EXPLOITATION ESTIMATES

Effort decreased in subareas A and D by 94 and 48%, respectively, and the exploitation estimates from the survey and the depletion model for commercial log data (D only) indicated similar concurrent decreases in exploitation (Figure 32). Smaller decreases were recorded for subareas B (10%) and C (12%). In subarea B, the survey estimates indicated a 19% decrease in exploitation, while the depletion-based estimates in 2012 increased from 2011. In subarea C, the depletion estimates indicated a slight decline, while the survey estimates indicated a slight increase in exploitation from 2011.

OTHER CONSIDERATIONS

An assessment of lobster bycatch in the SFA 29 West scallop survey and the fishery is presented here. Further information on bycatch for the SFA 29 West fishery, including non-lobster species, can be found in Sameoto and Glass (2012).

LOBSTER CATCH IN THE SURVEY

Information on lobster caught in the SFA 29 West survey has been recorded since 2001. The spatial distribution of lobster caught in the 2012 survey is presented in Figure 33. The lobster data were standardized to an 800 m tow length and the mean number per tow was determined using the same methods described for scallops. The mean number of lobster per tow increased from 2011 to 2012 in subareas A-D (Figure 34). The greatest increase was in subarea D, which had 0.34 lobster per tow in 2011 and 2.9 in 2012. Subarea B had the greatest number of lobster per tow in 2012 at 8.3.

LOBSTER CATCH IN THE FISHERY

The level of observer coverage has been variable over the history of this fishery (Table 3). Observer coverage can be characterized in terms of the number of observed tows, number of days observed and the number of observed trips. In 2012, there were 973 observed tows (460 East of Baccaro and 513 Full Bay), 33 days observed (16 East of Baccaro and 17 Full Bay) and 10 trips observed (4 East of Baccaro and 6 Full Bay).

As in previous years, most lobsters caught during the observed fishing trips were in subarea B closely followed by subarea C (Table 4; Figure 35).

To estimate the total number of lobsters caught during the SFA 29 scallop fishery, the number of lobsters caught during observed trips was converted to a number per ton of observed scallop catch in each subarea of SFA 29. This number was multiplied by the total scallop catch in each subarea. There were no lobsters observed in subarea D in 2012, so no estimate is available for

this area. It is assumed that the number of lobsters caught in each observed trip is representative of the whole fishery in each subarea.

Updated information has resulted in changes to the 2010 and 2011 estimates presented in Sameoto et al. (2012) and earlier documents. The entries in Table 4 should be considered the authoritative. The changes do not affect the described trends or conclusions in the previous document.

In 2012, it is estimated that 4,302 lobsters were caught during the SFA 29 West scallop fishery. This corresponds to a weight of approximately 2.8 t of lobsters using the average observed carapace length of 91 mm and weight of 0.64 kg caught in SFA 29 in 2012. This number is less than half of the previous year but is in line with the average estimates for the previous six years of 4,305 (Sameoto et al. 2012). The estimated number of lobster caught represents 0.01% of the lobsters caught in the 2011/2012 Lobster Fishing Area (LFA) 34 lobster fishery and 0.05% of the lobsters caught in the area of LFA 34 corresponding to SFA 29 West.

The numbers of dead or injured (DI) lobsters were estimated using the observed percentage of dead or injured lobsters in each subarea of SFA 29 and applying this to the estimated number of lobsters caught. In 2012, the estimated DI was 940. This is considerably less than 2011 but comparable with the average DI for the previous six years of 995 (Sameoto et al. 2012). In 2012, the highest level of dead or injured lobster was in subarea C at 781.

As far as the direct effects of the scallop fishery on the lobster stock, the only information available was the catch during the scallop fishery and the scallop survey. There were no available data on how any bottom impacts might have affected the lobster population. Some progress has been made on an analysis of underwater images to evaluate associations between lobster and habitat. This analysis indicates that there are significant associations between lobster and habitat, with lobsters more evident on coarse bottoms than on the gravel pavements typically associated with scallops (Tremblay et al. 2009).

Indirect information on the effect of the scallop fishery comes from trends in the lobster landings by the directed lobster fishery in LFA 34 (Table 5). Updated lobster landings have resulted in changes to the 2008 to 2011 values used in Sameoto et al. (2012) and earlier documents. The revised values show higher landings and a larger increase in the commercial lobster landings in the SFA 29 fishing areas than given in the previous documents.

Trends in lobster catches by the lobster fishery in the SFA 29 West area as a whole are not indicative of an area that has been adversely affected by the scallop fishery since 2001. Lobster landings in the area corresponding to SFA 29 West have increased steadily over the past several years and are up 52% over five years. Landings in the area adjacent to SFA 29 have also increased to a lesser extent and are up 35% over the last five years. LFA 34 lobster landings were at a record high for the 2011/2012 season at 23,294 t.

The lobster landing trends do not appear to be indicative of any negative impacts from the scallop fishery on the lobster fishery, but it is recognized that trends in landings by themselves cannot confirm there has been no effect.

STOCK STATUS AND ADVICE FOR 2013

The reasoning behind last year's TAC advice was based on reducing total fishing effort in each subarea in an attempt to lower exploitation and, in turn, to promote increases in biomass. The decreases in effort in 2012 for subareas B and C were more modest at 10 and 12%, respectively. Landings in subarea C were 12% below the quota, while the landings in subarea B were 30% above the quota. Commercial catch rates for 2012 in subarea C indicated little change from 2011, while they increased in subarea B. The number per tow from the 2012 survey was also unchanged from 2011 in subarea C, and the weight per tow indicated a small

increase. Both survey number per tow and weight per tow exhibited the highest increases in subarea B. However, the survey indices in the high suitability areas in B are at 33% of their maximum and below their respective mean over the times series. Growth and condition also showed large increases in 2012 in these two subareas. The results from the exploitation estimates were mixed for these two subareas, however, exploitation did decline from 2011 in both subareas if more emphasis is placed on the exploitation estimates that closely tracked the effort trends.

With the exception of subarea C, all areas exhibited increases in mean numbers and mean weight per tow from the survey in response to the decrease in effort, keeping in mind that the concurrent increase in growth and condition are also factors in the increase in mean weight. Past experience indicates that both growth and condition trends are highly variable in SFA 29, and there is no way of predicting what the trend will be in 2013. All areas exhibited increased numbers of pre-recruit scallops in the 2012 survey offering a potential for improved prospects in two to three years. It is recommended to continue with a total TAC of 160 t in 2013, with a reduction in subarea C to 30 t to see if this area will show more of a recovery and a concurrent increase in subarea B to 75 t, because, based on the 2012 data, abundance and biomass appear to be higher there than previously expected.

ACKNOWLEDGEMENTS

The authors thank the Captain and crew of the F/V *Hit 'N' Miss* for their participation in the 2012 survey. Alan Reeves and Amy Glass provided comments on the original draft. Jae Choi provided helpful comments at the review meeting and on the presentation version of this report.

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TABLES

Table 1. Scallop landings, total allowable catch (TAC), and landings for food and ceremonial purposes (FSC) by First Nations (meats, t) for Scallop Fishing Area (SFA) 29 West from 2006 to 2012. TAC for subareas A and E are combined. Landings by fleets were combined in 2010, 2011 and 2012.

Year	Subarea	*Full Bay*		*East of Baccaro*		*First Nation*	*Total*	
		TAC (t)	Landings (t)	TAC (t)	Landings (t)	FSC (t)	TAC (t)	Landings (t)
2006	A	18.75	20.4	6.25	1.1	-	25	21.5
	E		0.8		1	-		1.8
	B	93.75	87.9	31.25	27.8	-	125	115.7
	C	75	85.7	25	25.6	-	100	111.3
	D	112.5	113	37.5	42.9	6.0	150	161.9
	Total	300	307.7	100	98.4	6.0	400	412.1
2007	A	18.75	10.49	6.25	0.1	-	25	10.59
	E		0.2			-		0.2
	B	75	56.2	25	24.32	-	100	80.52
	C	37.5	48.5	12.5	10.9	-	50	59.4
	D	56.25	68	18.75	26.35	5.4	75	99.75
	Total	187.5	183.4	62.5	61.7	5.4	250	250.5
2008	A	7.5	3.05	2.5		-	10	3.05
	E		0.65		0.44	-		1.09
	B	82.5	44.65	27.5	20.5	-	110	65.15
	C	33.75	42	11.25	12.3	0.2	45	54.5
	D	63.75	99.9	21.25	26.1	5.6	85	131.6
	Total	187.5	190.3	62.5	59.3	5.8	250	255.4
2009	A	9.75	4.47	5.25	0.05	-	15	4.52
	E		0.01		1.96	-		1.97
	B	48.75	36.46	26.25	23.43	-	75	59.89
	C	48.75	50.19	26.25	27.35	0.7	75	78.24
	D	55.25	67.2	29.75	31.46	5.4	85	104.06
	Total	162.5	158.38	87.5	84.23	6.1	250	248.71

		Fleets Combined		*First Nation*	Total
Year	Subarea	TAC (t)	Landings (t)	FSC (t)	Landings (t)
2010	A	25.0	9.4	0.0	9.4
	E		5.4	-	5.4
	B	65.0	50.7	0.3	51.0
	C	45.0	60.6	-	60.6
	D	65.0	72.1	4.7	76.8
	Total	200.0	198.2	5.0	203.2
2011	A	25.0	18.1	-	18.1
	E		5.6	-	5.6
	B	65.0	59.3	-	59.3
	C	45.0	45.5	-	45.5
	D	65.0	65.7	3.2	68.9
	Total	200.0	194.1	3.2	197.3
2012	A	25.0	1.02	-	1.0
	E		17.9	-	18.0
	B	60.0	76.8[1]	4.2	81.0
	C	45.0	39.8	0.03	39.8
	D	30.0	31.7[2]	0.4	32.1
	Total	160.0	167.2	4.7	168.9

1. Includes 5.2 t landed during August 30 to September 15 re-opening.
2. Includes 1.1 t landed during August 30 to September 15 re-opening.

Table 2. Percent of usable commercial log records from SFA 29 West from 2002–2012.

Year	Usable Log Records	Total Log Records	% Usable
2002	1551	1768	88
2003	762	824	92
2004	1458	1633	89
2005	835	966	86
2006	1385	1749	79
2007	918	1090	84
2008	919	1079	85
2009	966	1067	91
2010	928	1002	93
2011	1119	1125	99
2012	735	747	98

NOTE: The year 2001 is not presented due to a change in the commercial log system in 2002.

Table 3. Number of tows, days and trips observed during the SFA 29 fishery, 2001–2012 for East of Baccaro (EoB) and Full Bay (FB) fleets.

Year	TOWS OBSERVED		DAYS OBSERVED		TRIPS OBSERVED	
	EoB	FB	EoB	FB	EoB	FB
2001	-	2,014	-	97	-	45
2002	1,933	2,521	78	98	33	36
2003	820	1,524	33	56	10	18
2004	1,305	3,135	42	103	13	31
2005	502	1,414	15	50	5	14
2006	895	2,157	30	67	7	17
2007	3	947	1	28	1	7
2008	548	1,969	17	67	4	19
2009	579	1,212	17	38	4	10
2010	361	1,045	15	38	3	8
2011	307	940	13	36	3	7
2012	460	513	16	17	4	6

Table 4. Estimated total numbers of lobsters caught in the scallop fishery (Full Bay and East of Baccaro combined) for 2010–2012 based upon observer data. DI (%) refers to the percentage of dead or injured lobsters. (Changes have been made to 2010 and 2011 estimates and the current values may differ from those in Sameoto et al. (2012) and earlier documents. The present version should be considered authoritative.)

Year	Subarea	Observer data			Fishery	Estimated	
		No. lobsters	DI (%)	Meats (t)	Meats (t)	No. lobsters	DI (%)
2010	B	159	20	5.9	51.0	1,369	276
	C	107	32	3.7	60.6	1,754	557
	D	2	50	2.4	76.8	65	32
	E	12	8	1.1	5.4	60	5
	Total	**280**		**13.1**	**193.8**	**3,248**	**870**
2011	A	24	46	0.6	18.1	680	312
	B	735	33	6.4	59.3	6,852	2,265
	C	1		0.1	45.4	339	0
	D	18	100	6.7	69.8	189	189
	E	188	61	2.0	5.6	533	323
	Total	**966**		**15.8**	**198.1**	**8,593**	**3,089**
2012	A	24	0	0.4	1.0	58	0
	B	164	9	8.5	78.1	1,512	135
	C	104	49	2.6	39.8	1,593	781
	E	47	2	0.7	18.0	1,138	24
	Total	**339**		**12.2**	**168.9**	**4,302**	**940**

NOTE: There were **15** lobsters in 2010 (B – 14, D – 1), **16** in 2011 (C – 1, D – 15) and **10** lobsters in 2012 (B – 7, C – 3) that were counted but not measured or assessed for condition. A percentage of these are likely dead or injured. These have been included in the No. lobsters above, but assumed alive, without injury.

Table 5. Recent lobster landings (t) by the Lobster Fishing Area (LFA) 34 lobster fishing fleet. Shown are the landings by SFA 29 West subarea, for SFA 29 West as a whole, for the area adjacent to SFA 29 West, and LFA 34 as a whole. (Corrections have been made to 2008–09 to 2010–11 landings and the current values may differ from those in Sameoto et al. (2012) and earlier documents. The present version should be considered authoritative.)

Area	2005–2006	2006–2007	2007–2008	2008–2009	2009–2010	2010–2011	2011–2012	% Change	
								1 year	5 year
A	340	366	605	596	586	451	379	-16%	4%
B	1,132	1,048	1,265	1,378	1,632	1,464	1,699	16%	62%
C	941	828	840	887	1,008	1,105	1,105	0%	34%
D	597	629	581	494	544	786	945	20%	50%
E	540	631	658	729	1,095	1,215	1,182	-3%	87%
SFA 29	3,550	3,500	3,949	4,083	4,865	5,021	5,310	6%	52%
Adjacent	4,670	4,716	5,017	5,381	5,681	5,845	6,375	9%	35%
LFA 34	17,009	16,583	17,145	17,262	19,749	20,401	23,294	14%	40%

FIGURES

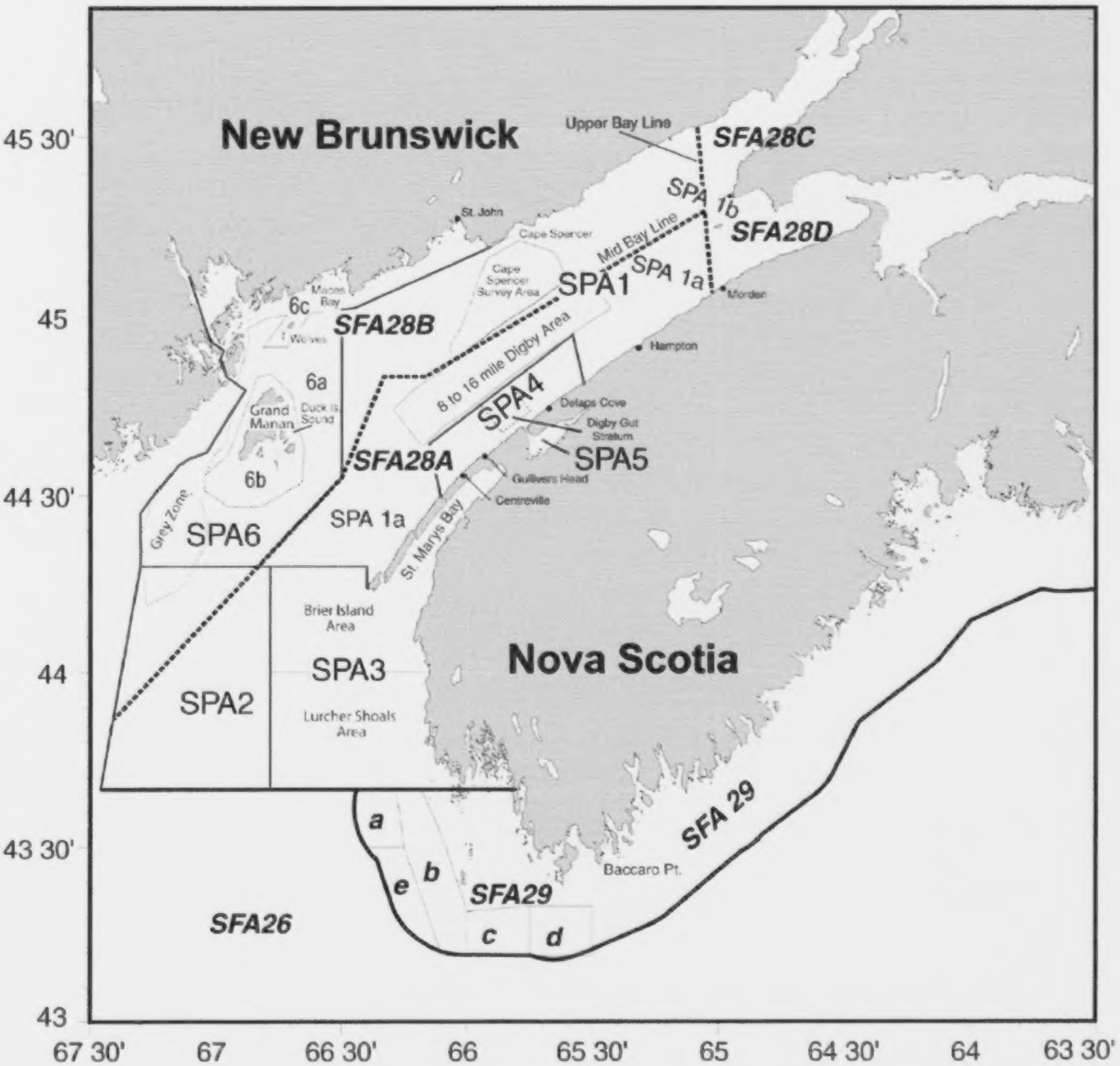

Figure 1. Map of Scallop Fishing Areas (SFAs) and Scallop Production Areas (SPAs).

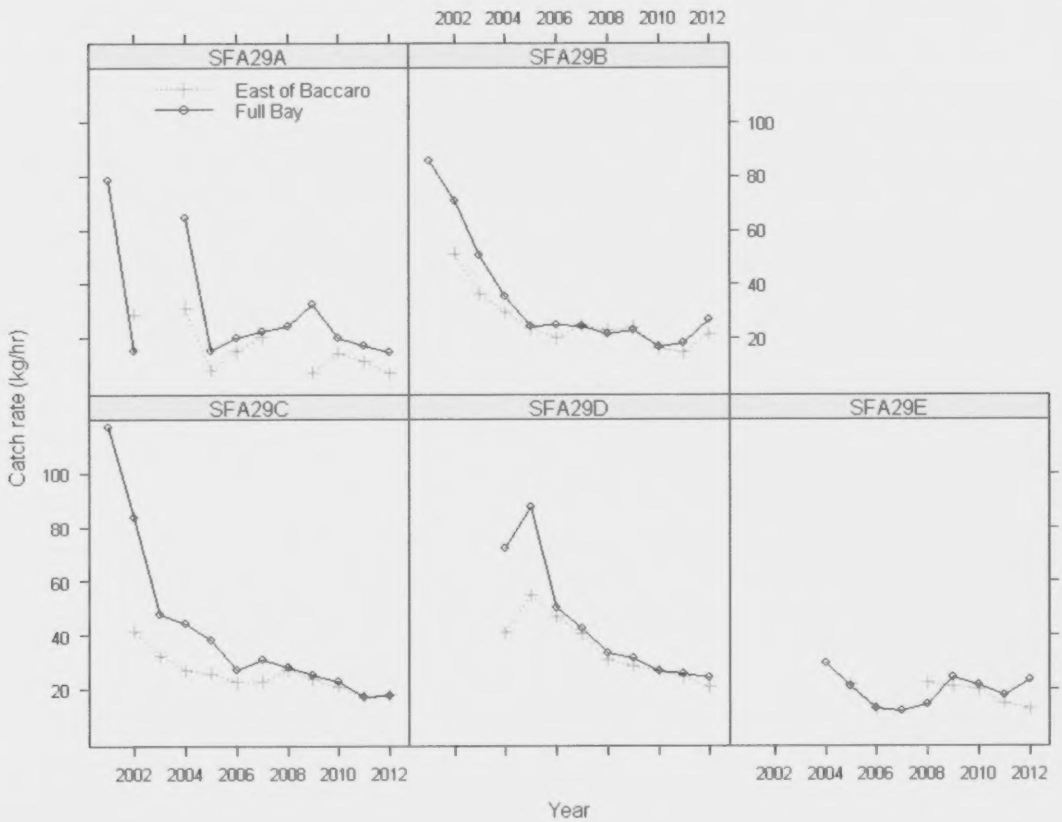

Figure 2. Annual trends for average commercial catch rate (kg/h) for SFA 29 West scallop fishery for each subarea by fleet, from 2001–2012.

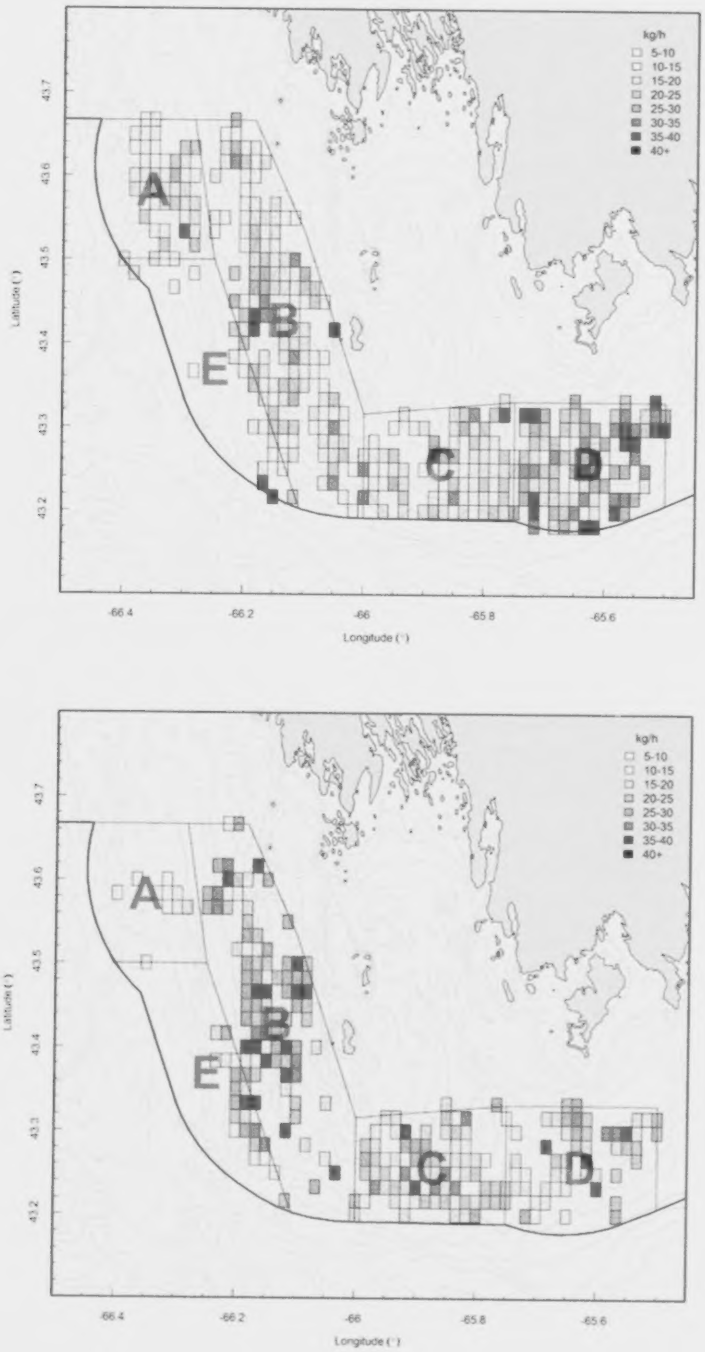

Figure 3. Spatial map of catch per unit effort (kg/h) for the fishery in SFA 29 West for 2011 (top) and 2012 (bottom). Locations from both fleets obtained from the commercial fishing log..

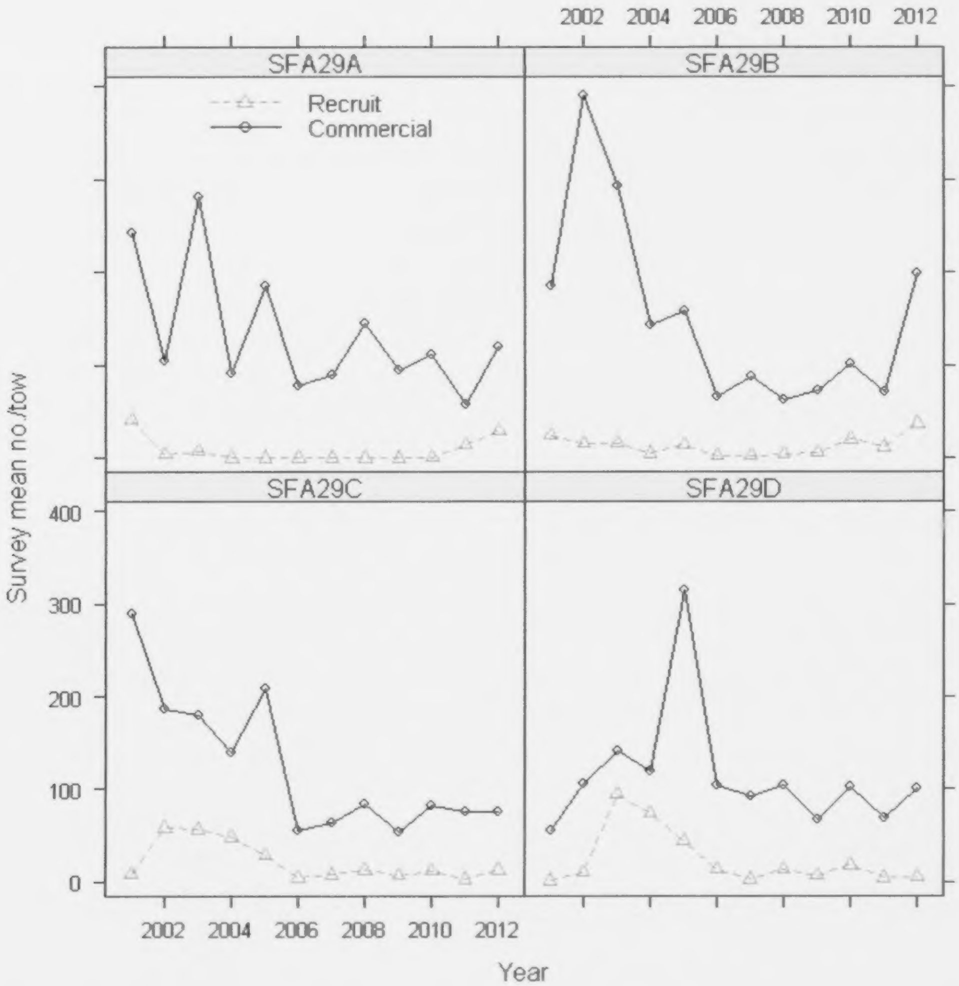

Figure 4. Annual trends in estimated mean number per tow of commercial (≥ 100 mm shell height) and recruit (90–99 mm shell height) size classes from research surveys by subarea in SFA 29 West. Commercial and recruit series estimated from fishing vessel (F/V) Julie Ann Joan (2001–2003, 2005–2011),F/V Branntelle (2004), F/V Overton Bay (2005), F/V Faith Alone (2006–2011) and F/V Hit 'N' Miss (2012). Geophysical strata was used for survey design.

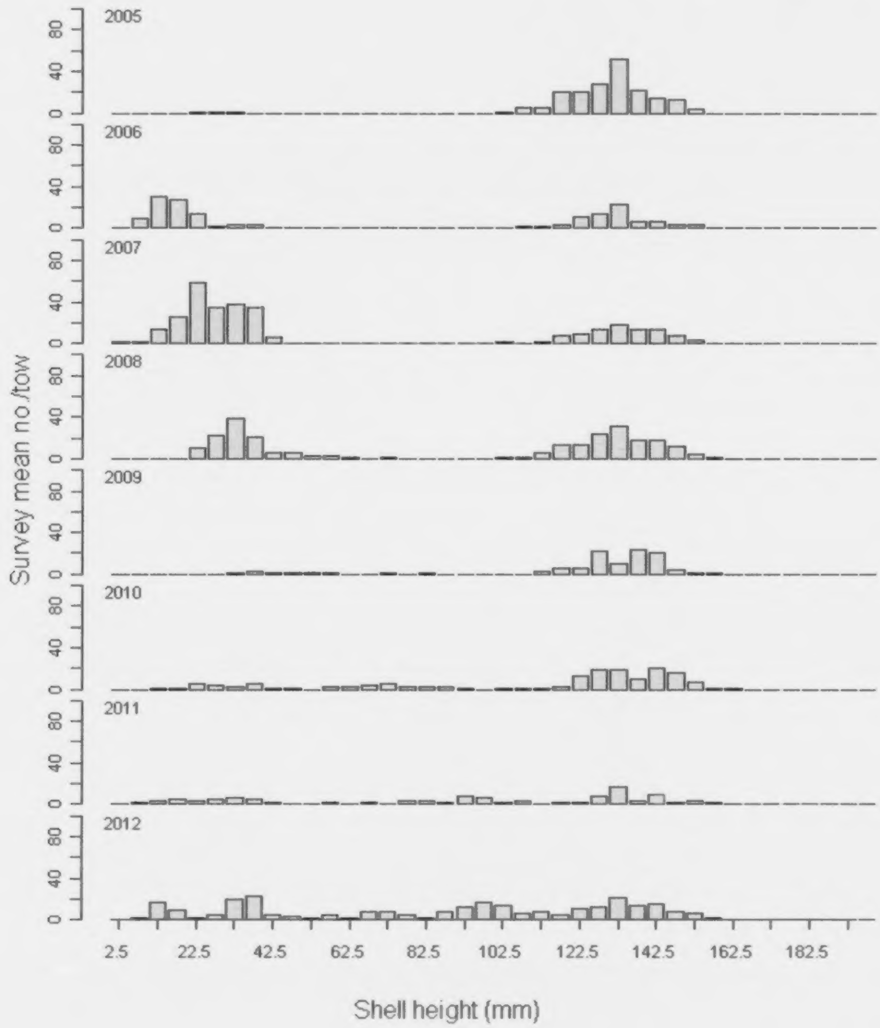

Figure 5. Scallop shell height (mm) frequencies (mean number/tow) from the surveys in SFA 29 West subarea A (2005–2012).

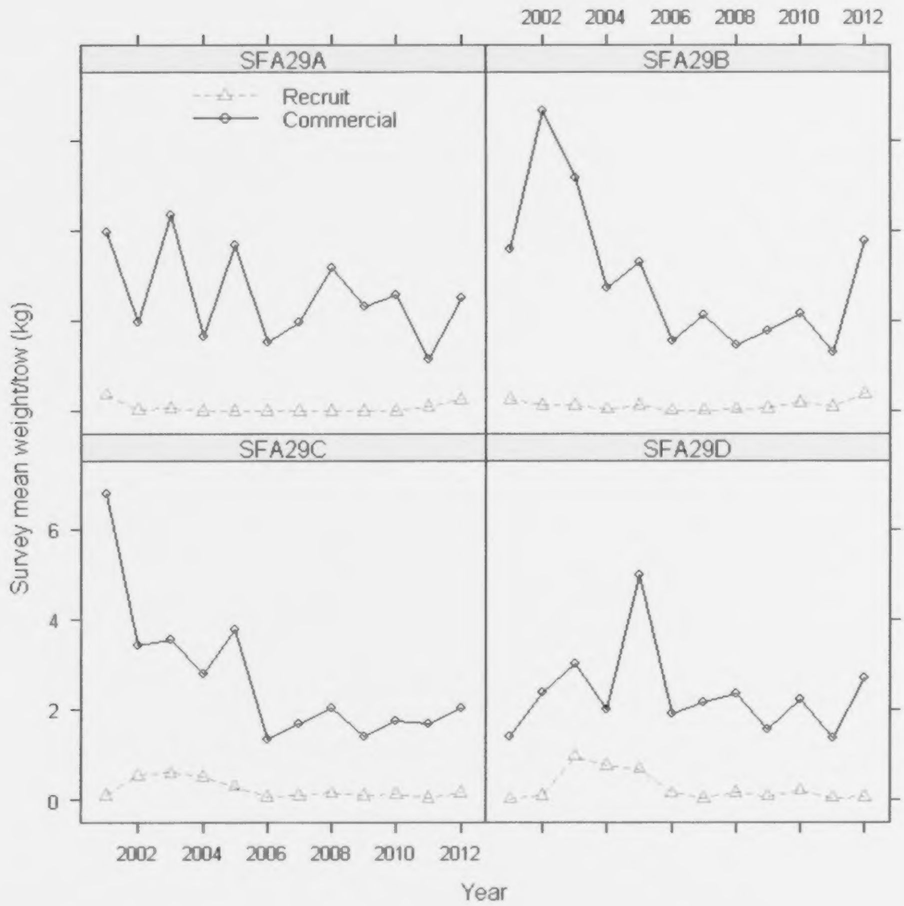

Figure 6. Annual trends in estimated mean weight per tow (meats, kg) of commercial (≥ 100 mm shell height) and recruit (90–99 mm shell height) size classes from research surveys by subarea in SFA 29 West. Commercial and recruit series estimated from fishing vessel (F/V) Julie Ann Joan (2001–2003, 2005–2011),F/V Branntelle (2004), F/V Overton Bay (2005), F/V Faith Alone (2006–2011) and F/V Hit `N' Miss (2012). Geophysical strata was used for survey design.

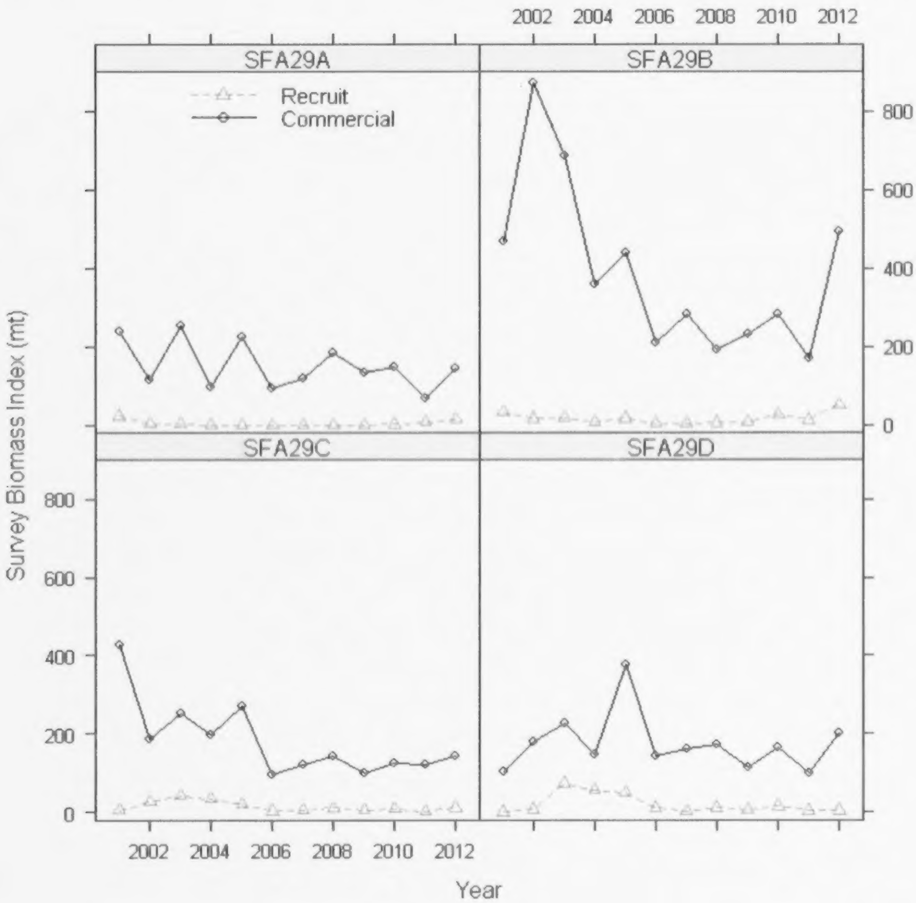

Figure 7. Annual trends in survey biomass (meats, mt) of commercial (≥ 100 mm shell height) and recruit (90–99 mm shell height) size classes from research surveys by subarea in SFA 29 West. Commercial and recruit series estimated from fishing vessel (F/V) Julie Ann Joan (2001–2003, 2005–2011), F/V Branntelle (2004), F/V Overton Bay (2005), F/V Faith Alone (2006–2011) and F/V Hit 'N' Miss (2012). Geophysical strata was used for survey design.

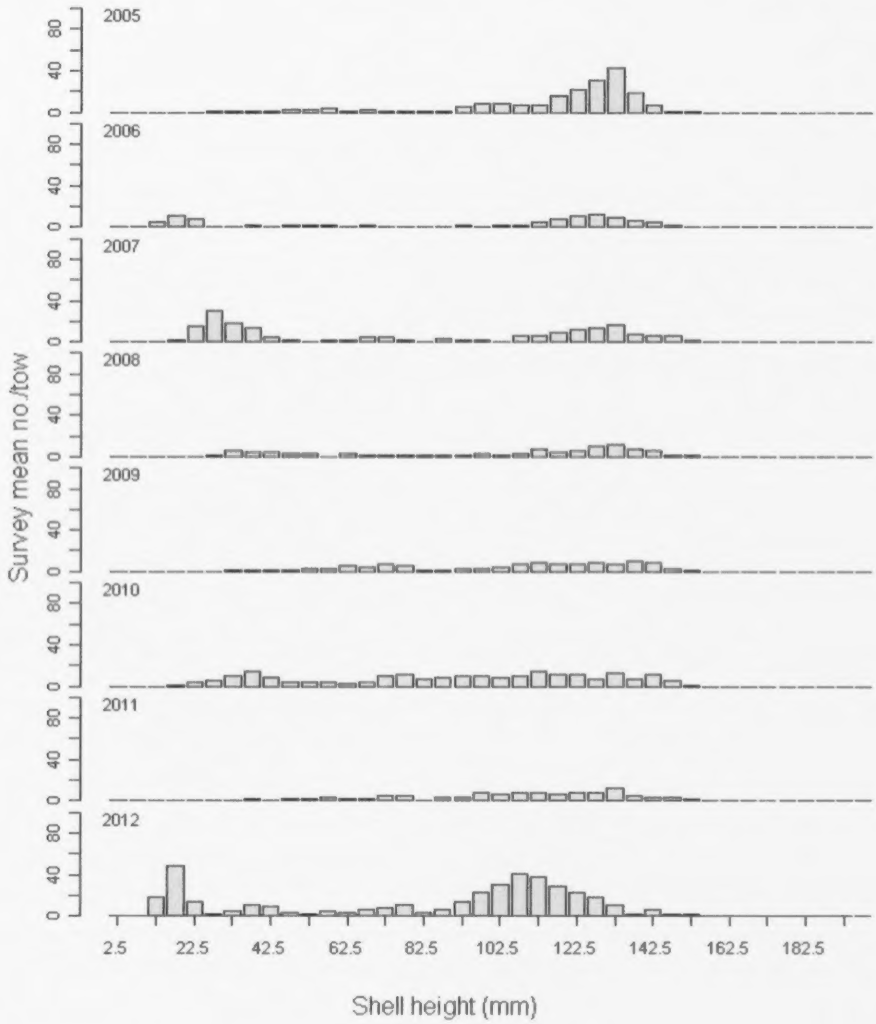

Figure 8. Scallop shell height (mm) frequencies (mean number/tow) from the surveys in SFA 29 West subarea B (2005–2012).

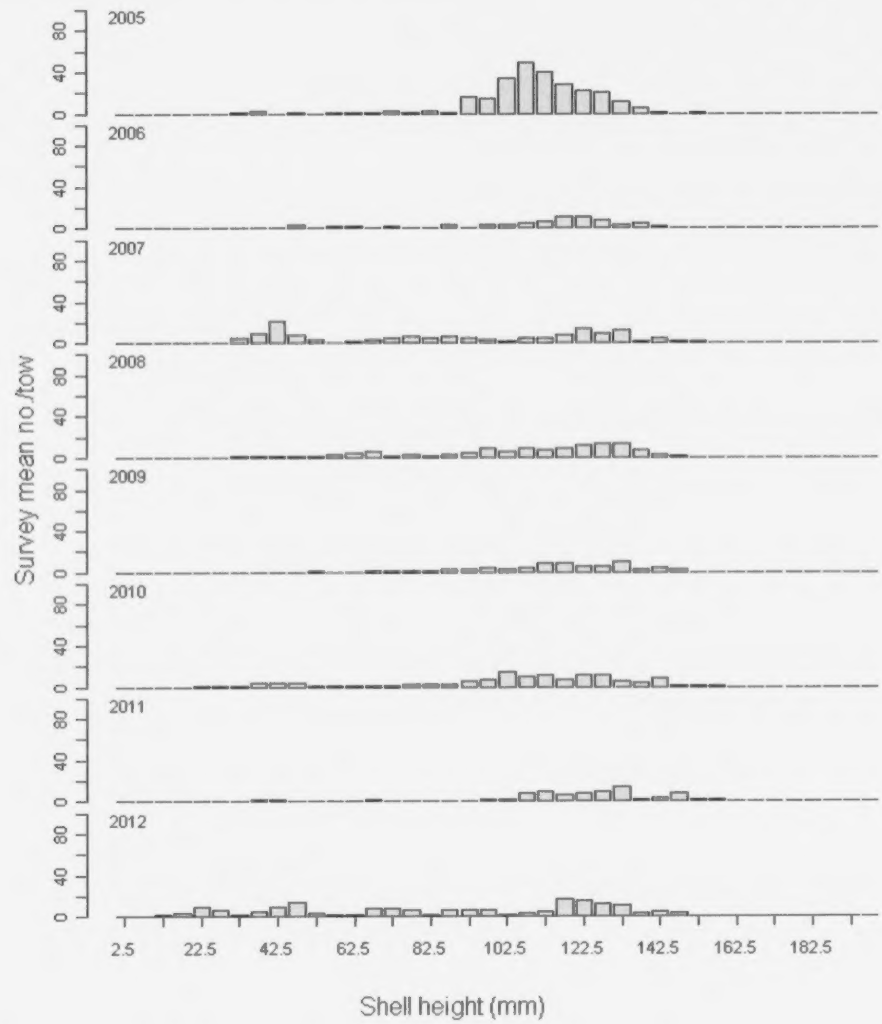

Figure 9. Scallop shell height (mm) frequencies (mean number/tow) from the surveys in SFA 29 West subarea C (2005–2012).

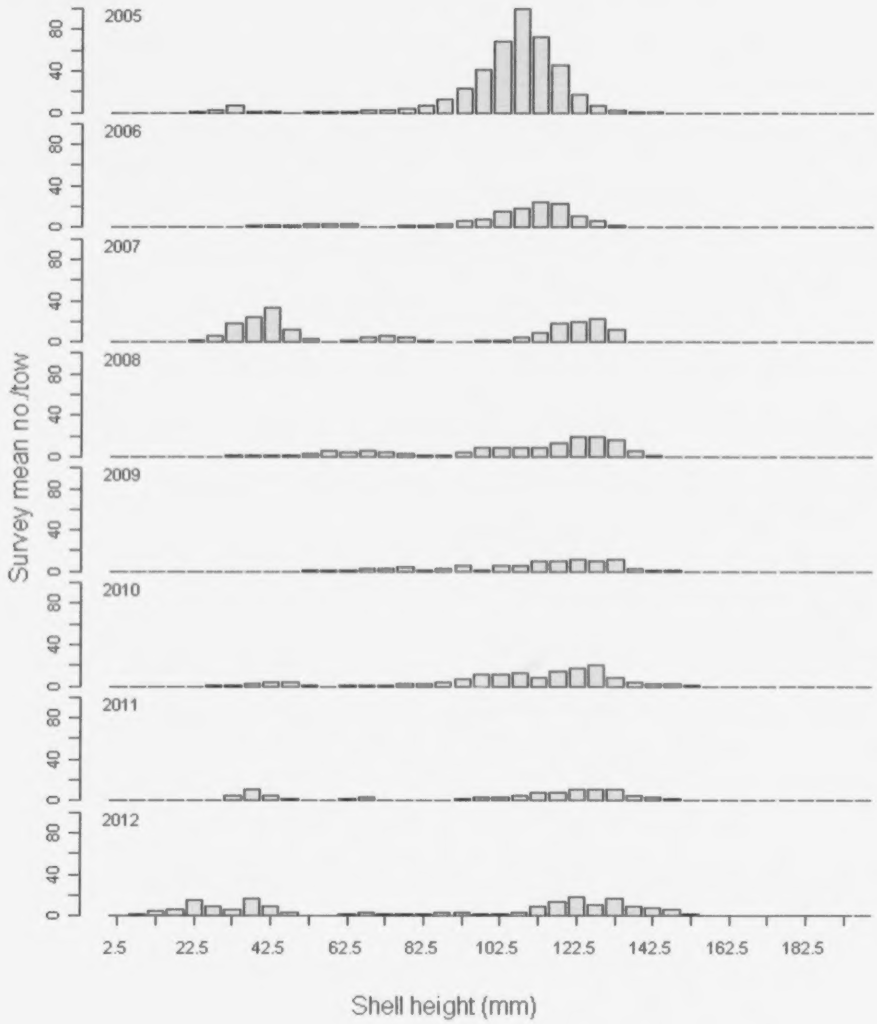

Figure 10. Scallop shell height (mm) frequencies (mean number/tow) from the surveys in SFA 29 West subarea D (2005–2012).

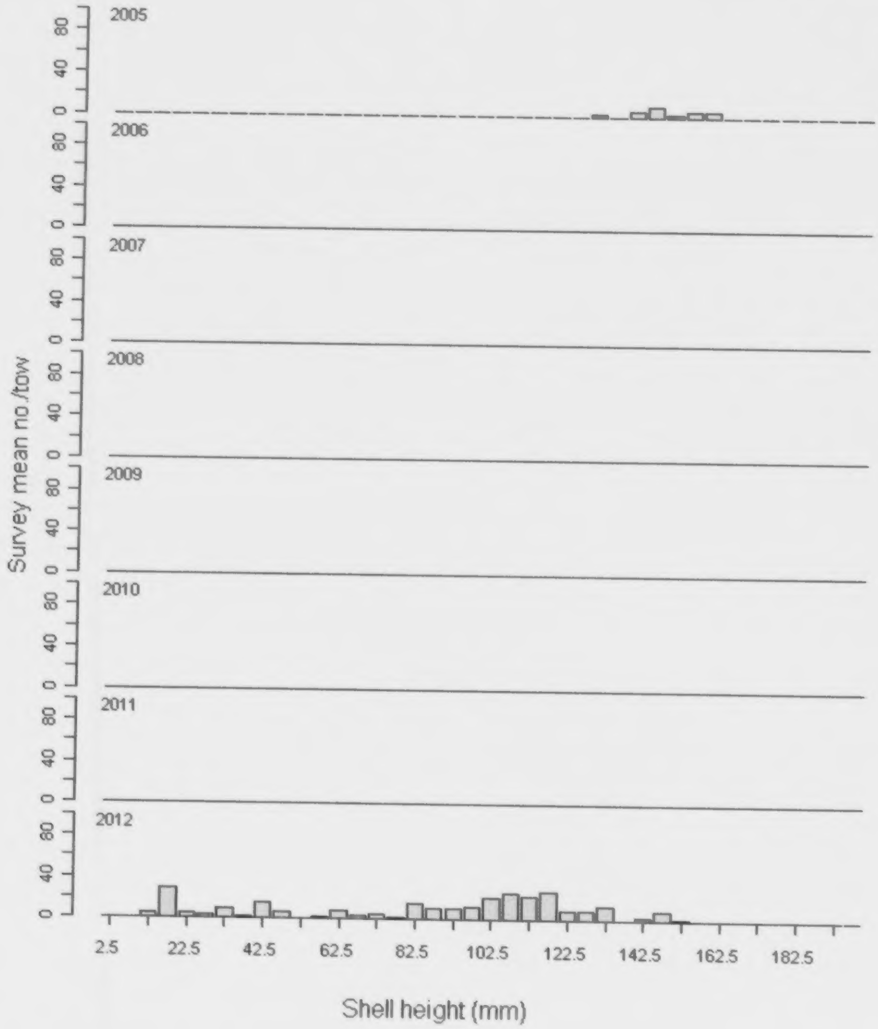

Figure 11. Scallop shell height (mm) frequencies (mean number/tow) from the surveys in SFA 29 West subarea E (2005–2012). Subarea E was not included in the survey from 2006–2011.

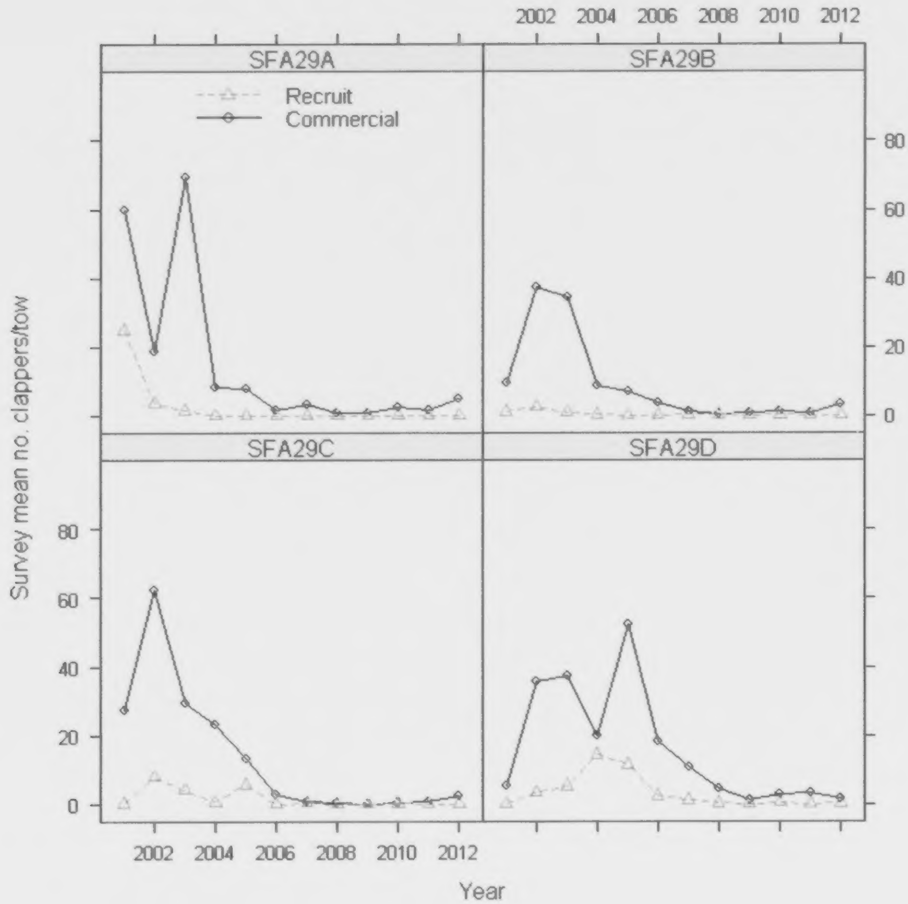

Figure 12. Annual trends in estimated mean number per tow of commercial (≥ 100 mm shell height) and recruit (90–99 mm shell height) size classes of clappers from research surveys by subarea in SFA 29 West commercial and recruit series estimated from F/V Julie Ann Joan (2001–2003, 2005–2011), F/V Branntelle (2004), F/V Overton Bay (2005), F/V Faith Alone (2006–2011) and F/V Hit 'N' Miss (2012). Geophysical strata was used for survey design.

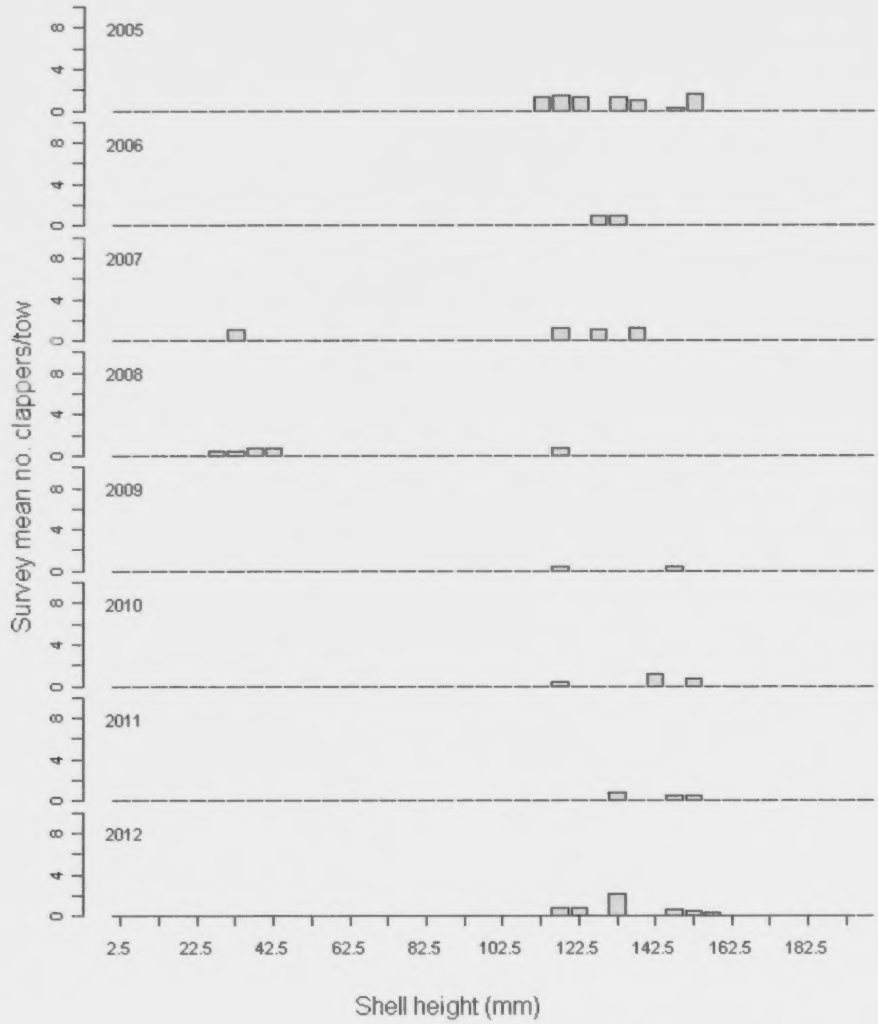

Figure 13. Scallop shell height (mm) frequencies for clappers (mean number/tow) from the surveys in SFA 29 West subarea A (2005–2012).

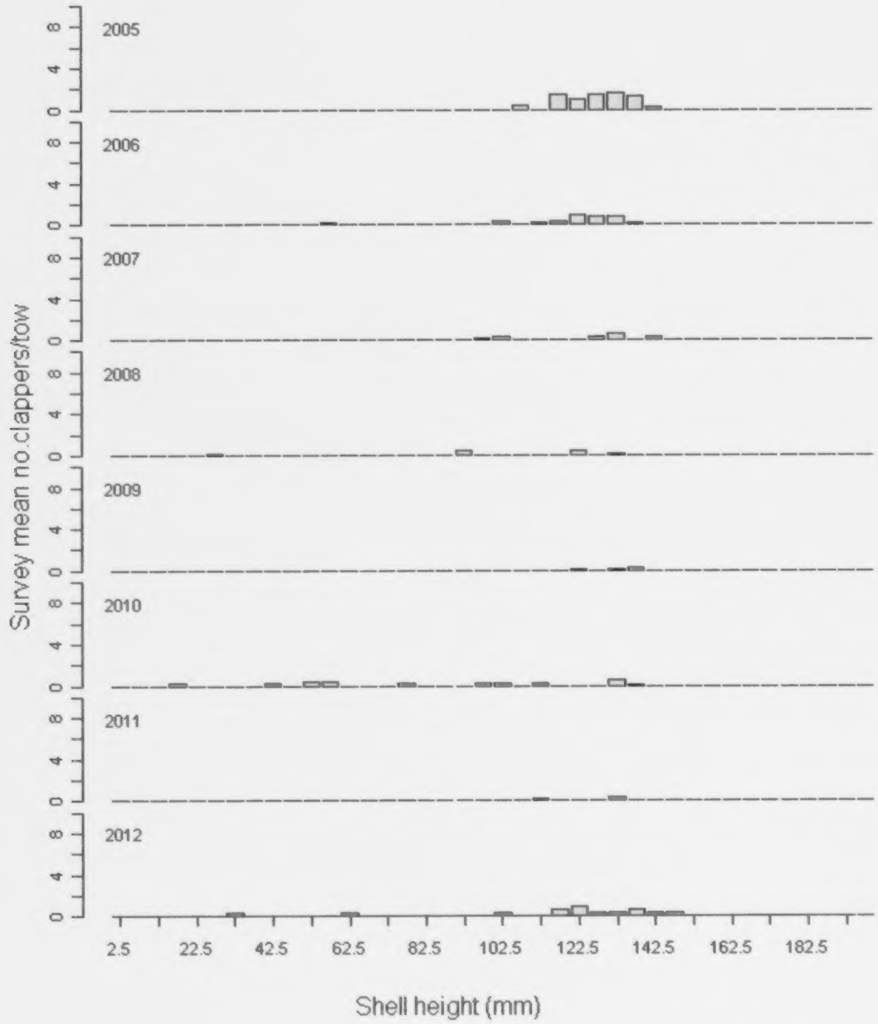

Figure 14. Scallop shell height (mm) frequencies for clappers (mean number/tow) from the surveys in SFA 29 West subarea B (2005–2012).

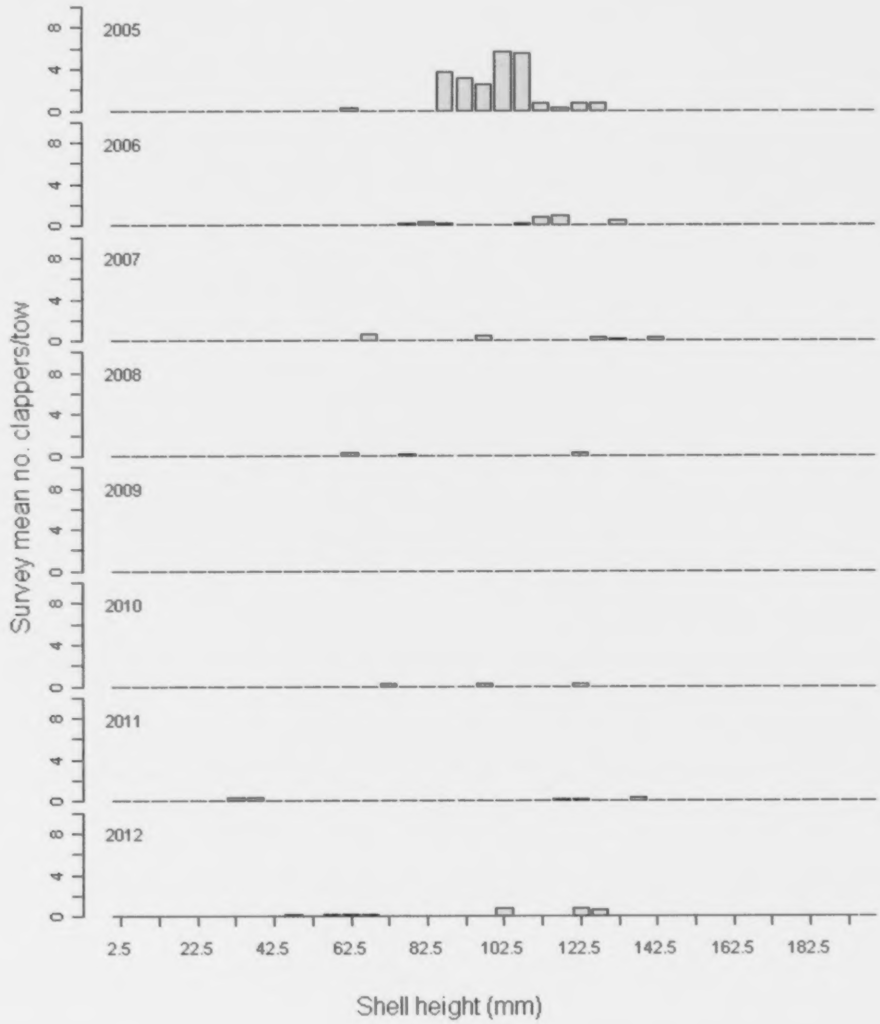

Figure 15. Scallop shell height (mm) frequencies for clappers (mean number/tow) from the surveys in SFA 29 West subarea C (2005–2012).

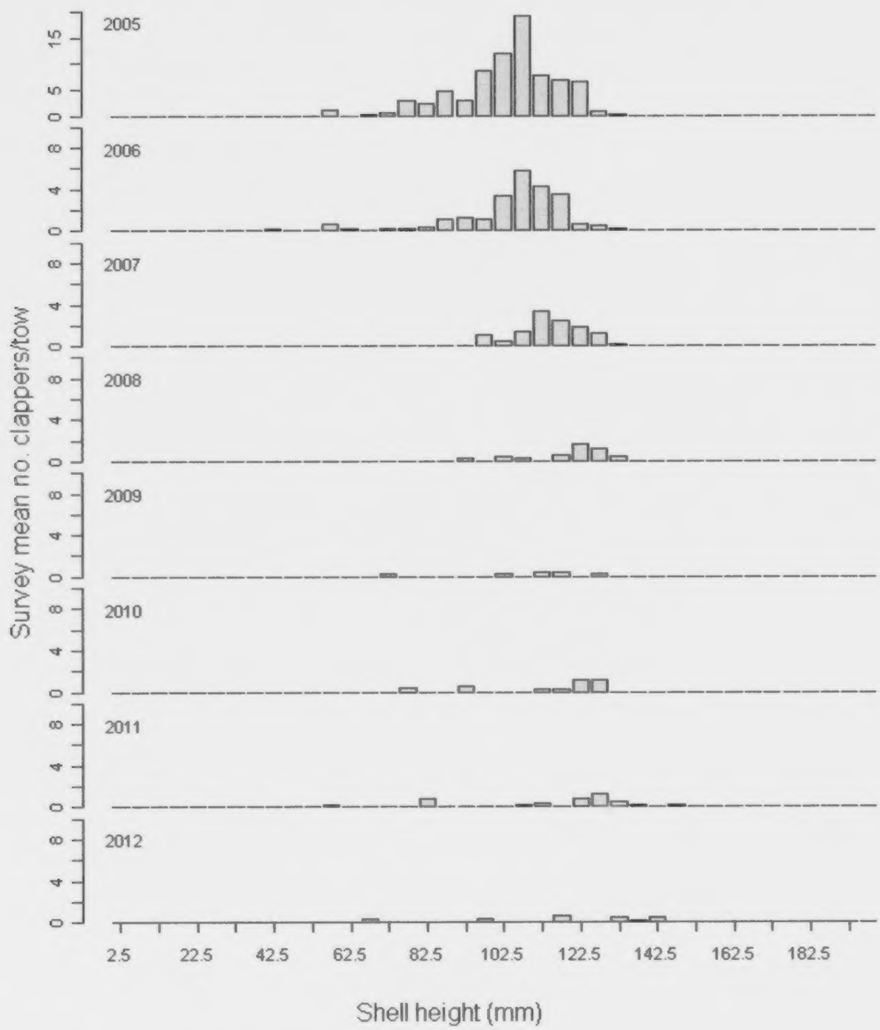

Figure 16. Scallop shell height (mm) frequencies for clappers (mean number/tow) from the surveys in SFA 29 West subarea D (2005–2012).

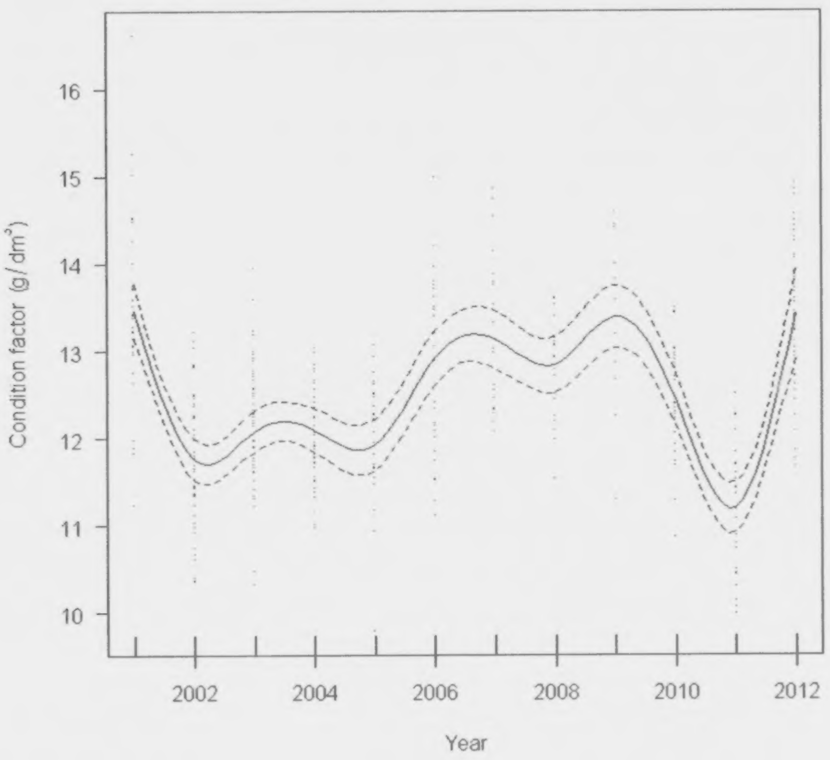

Figure 17. Fit of condition factor (g/dm^3) as a function of year from a generalized additive model. Shows the annual trend in condition factor for scallops from the annual surveys of SFA 29 West (2001–2012).

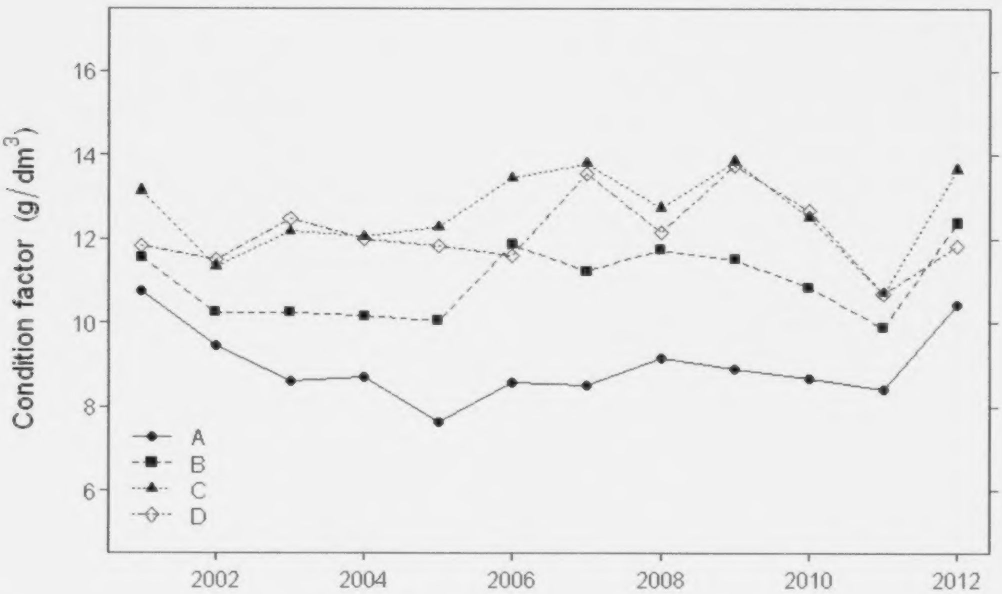

Figure 18. Annual trend in condition factor (g/dm^3) for scallops from the annual surveys of SFA 29 West by subareas A to D (2001–2012).

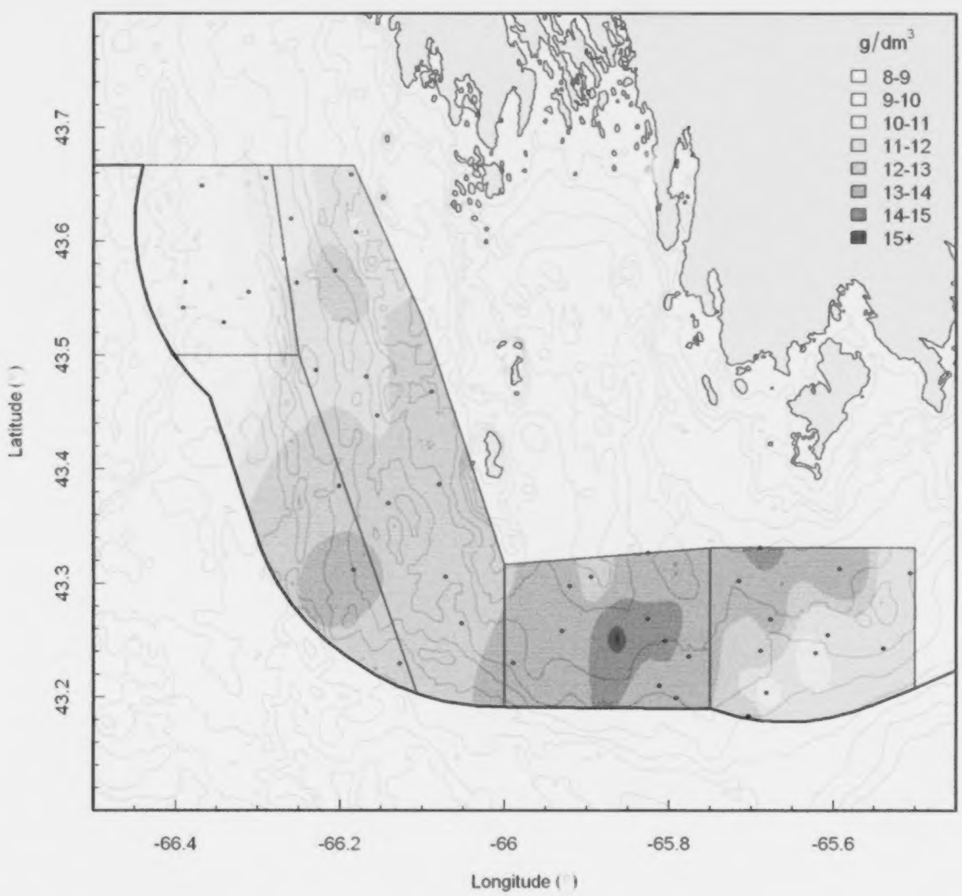

Figure 19. Spatial distribution of condition factor (g/dm^3) from the 2012 survey data for SFA 29 West.

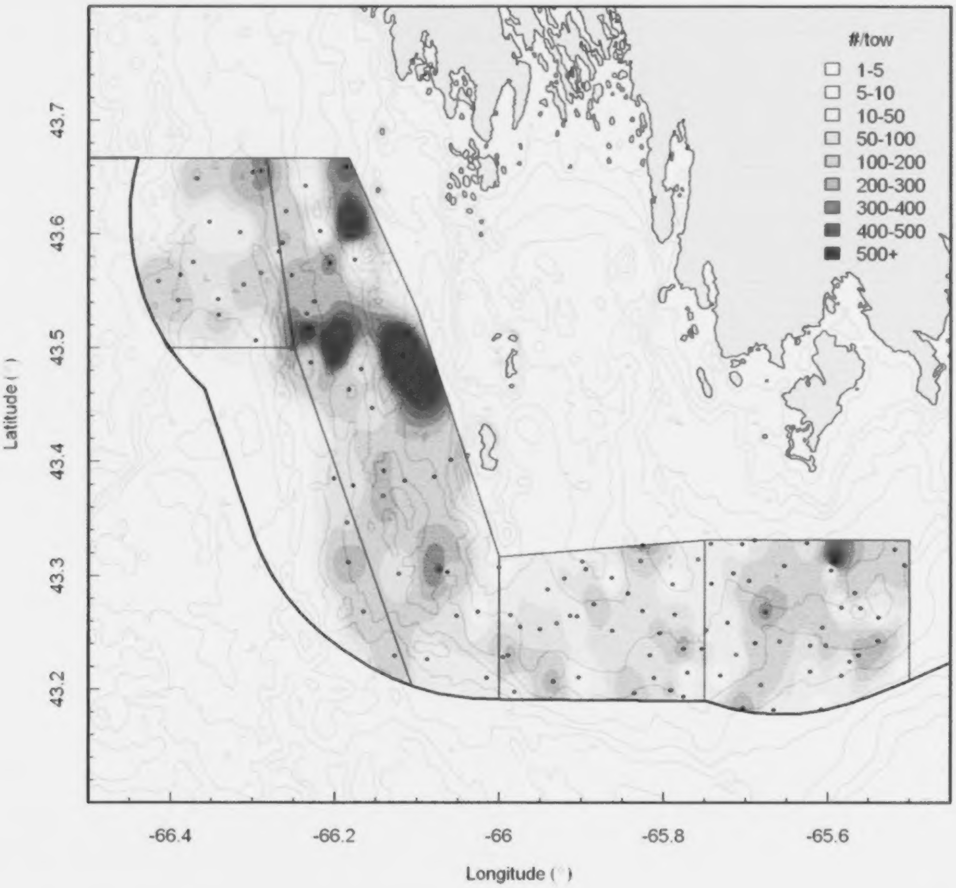

Figure 20. Spatial density (number/tow) distribution of commercial scallops (≥ 100 mm shell height) from the 2012 survey data for SFA 29 West.

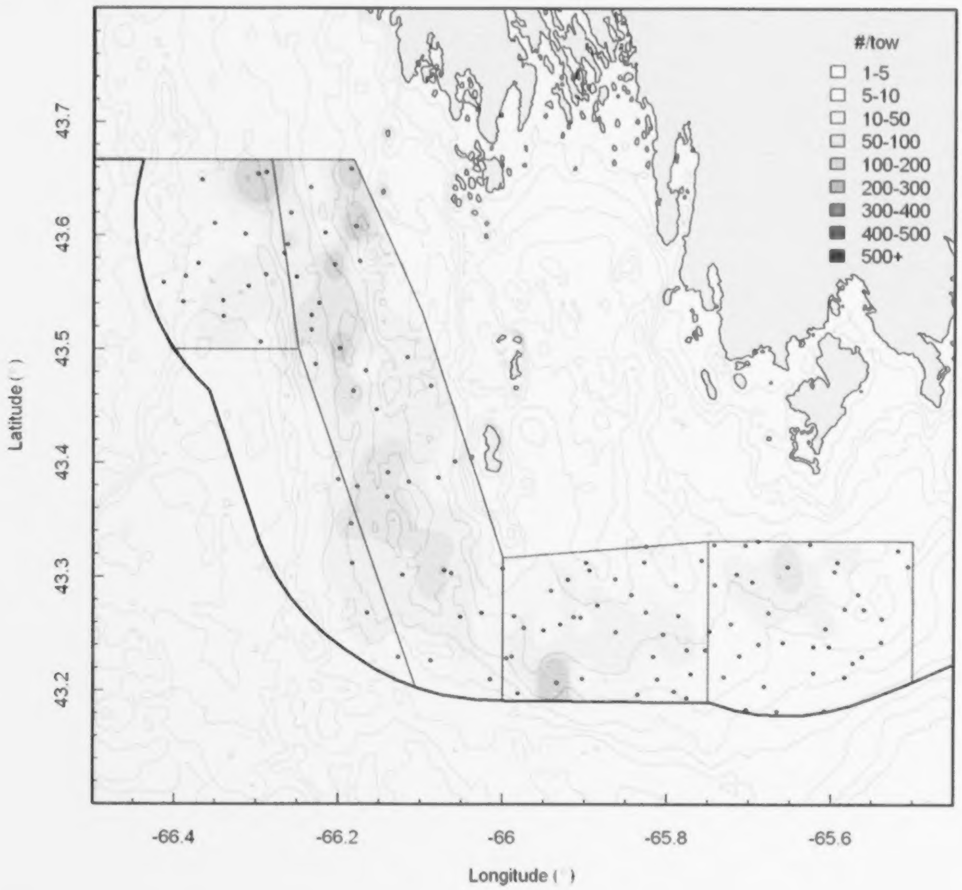

Figure 21. Spatial density (number/tow) distribution of recruit scallops (90–99 mm shell height) from the 2012 survey data for SFA 29 West.

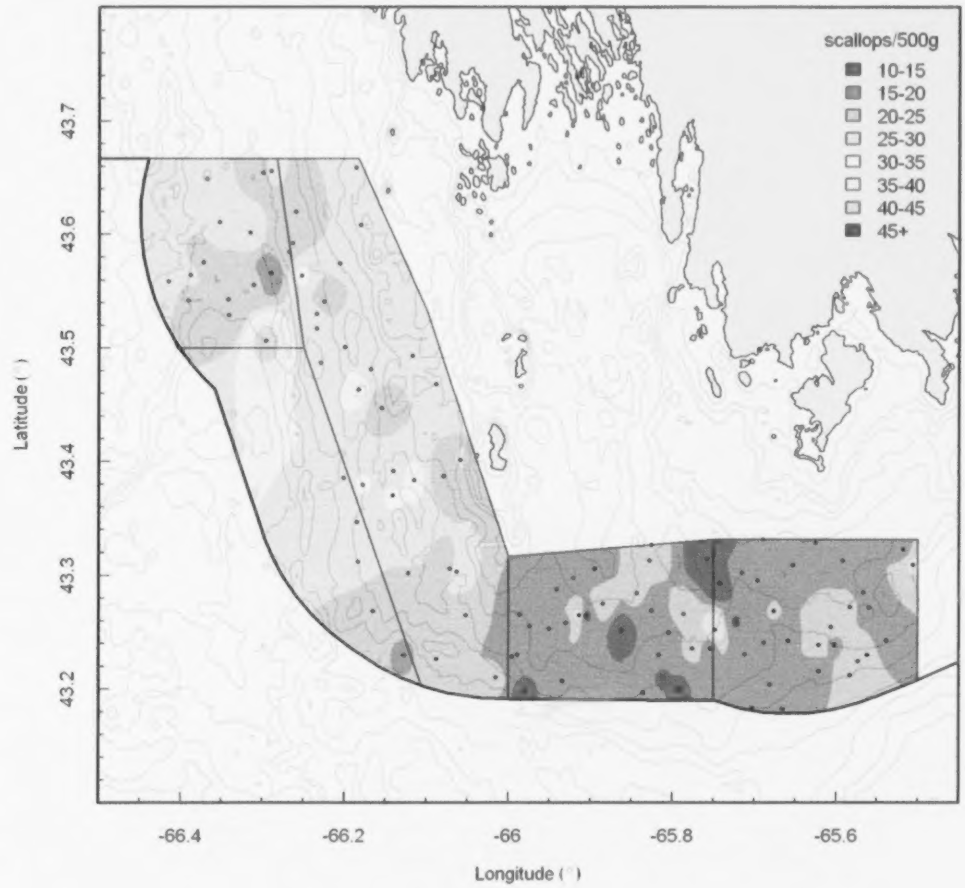

Figure 22. Spatial distribution of estimated meat count of commercial size (≥ 100 mm shell height) scallops from the survey of SFA 29 West in 2012.

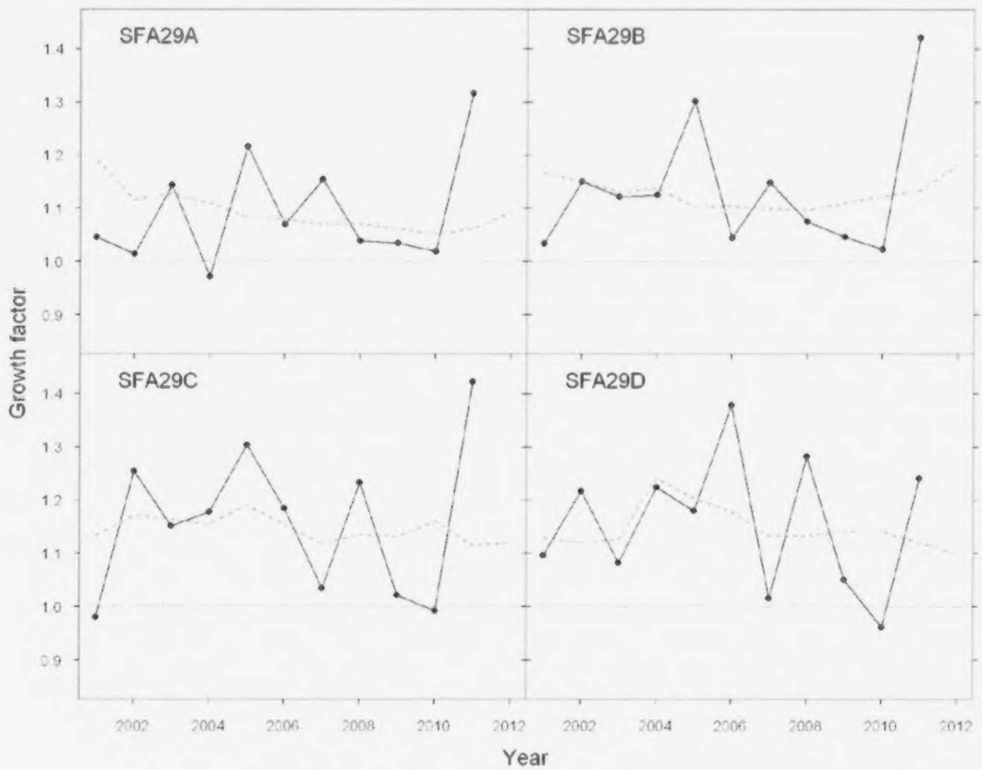

Figure 23. Annual observed growth factor for SFA 29 West by subarea A to D (2001–2012). Grey dashed line is the theoretical expected growth factor based on mean meat weight and the red dotted line indicates a growth factor of one or no growth.

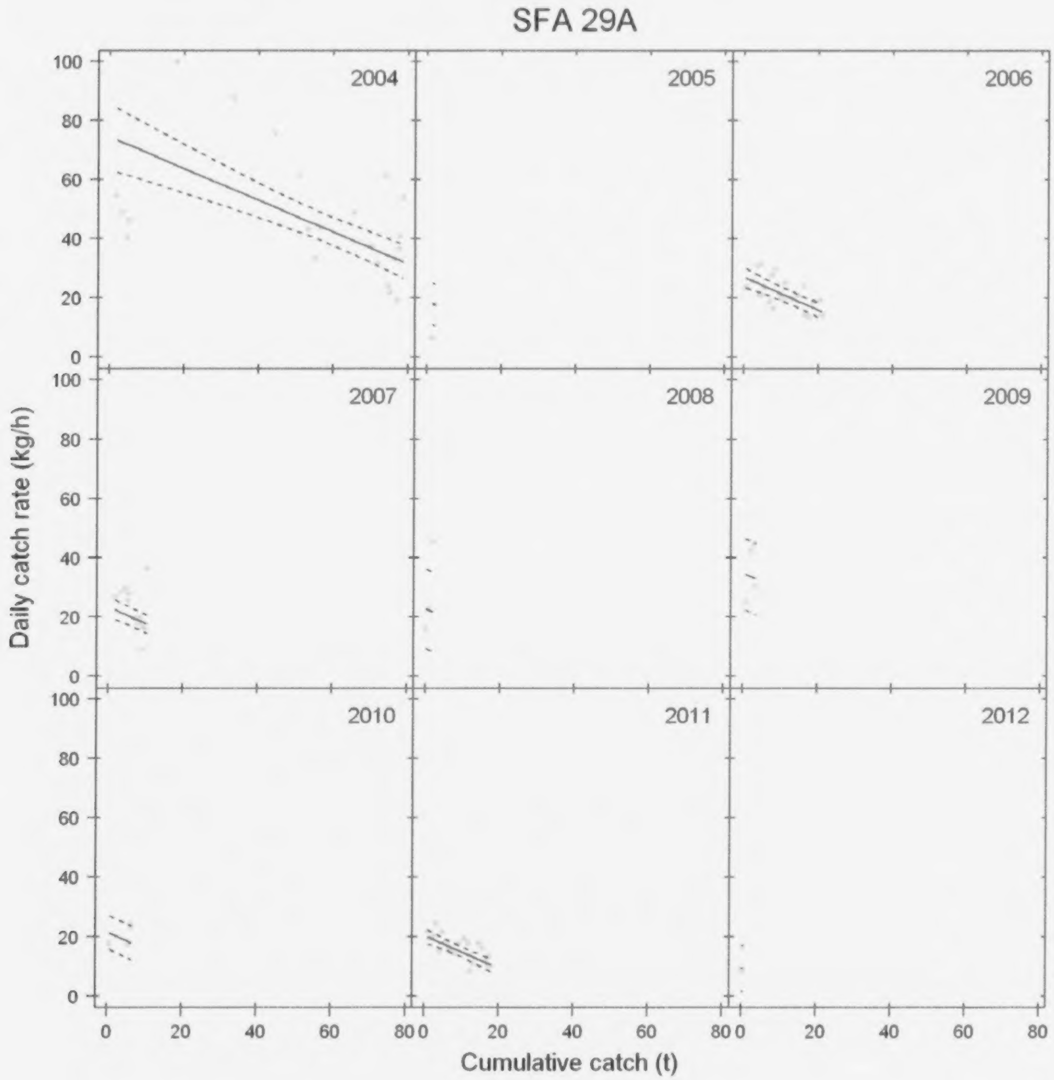

Figure 24. Depletion plots showing daily catch rates (kg/h) versus cumulative catch (t) and the Leslie model fit (with 95% credible interval (CI)) for SFA 29 West subarea A (2004–2012).

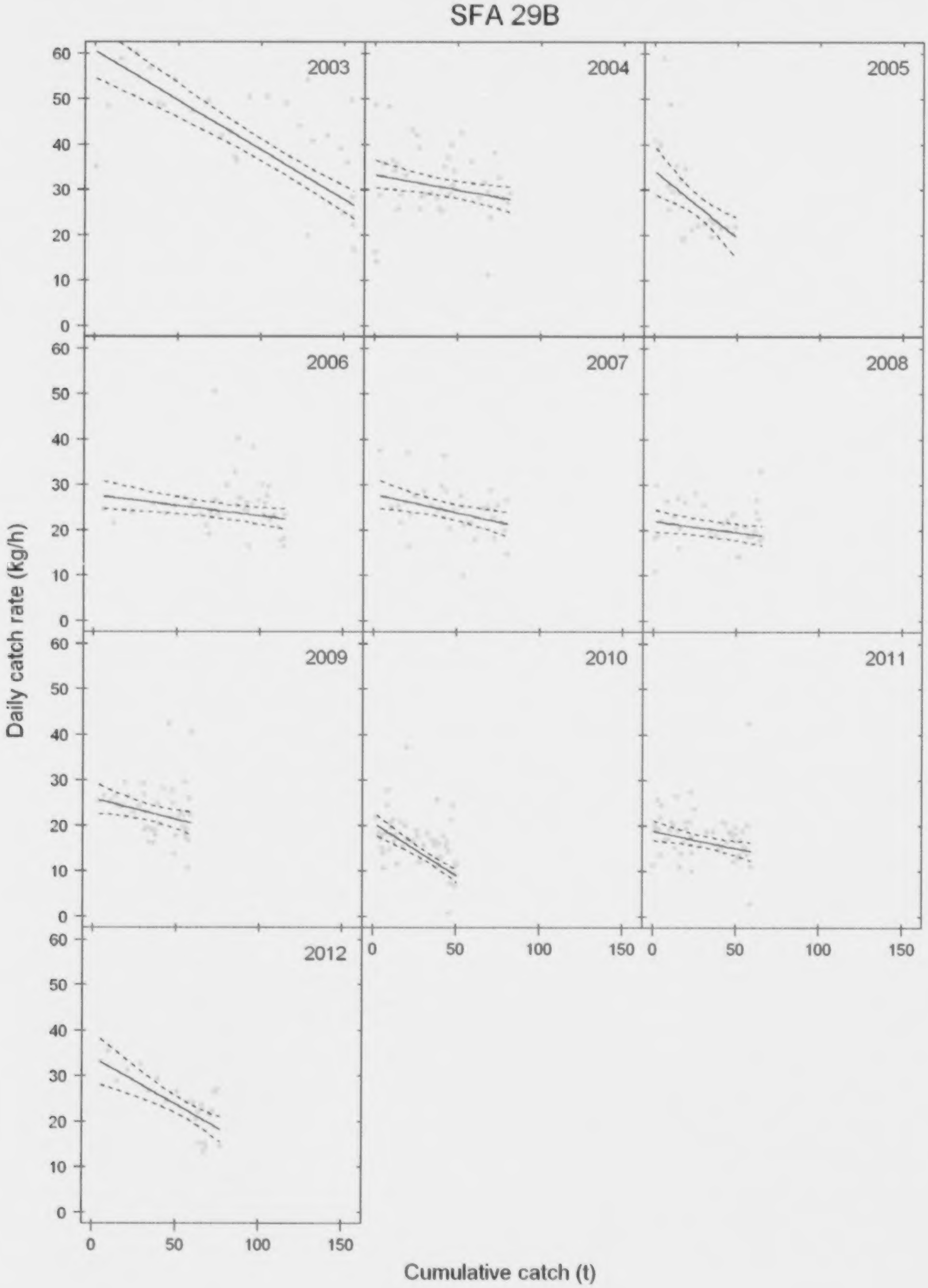

Figure 25. Depletion plots showing daily catch rates (kg/h) versus cumulative catch (t) and the Leslie model fit (with 95% CI) for SFA 29 West subarea B (2003–2012).

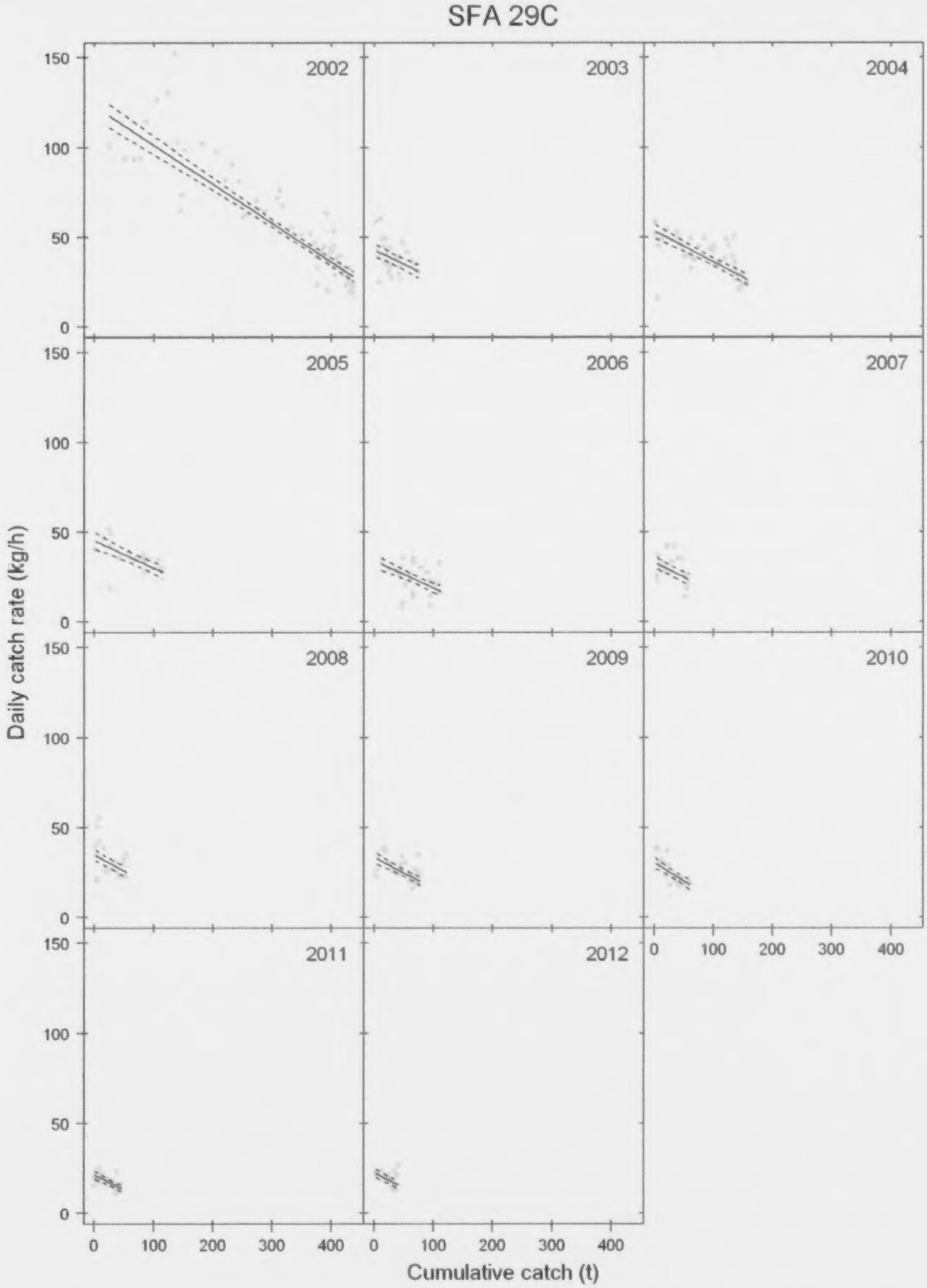

Figure 26. Depletion plots showing daily catch rates (kg/h) versus cumulative catch (t) and the Leslie model fit (with 95% CI) for SFA 29 West subarea C (2002–2012).

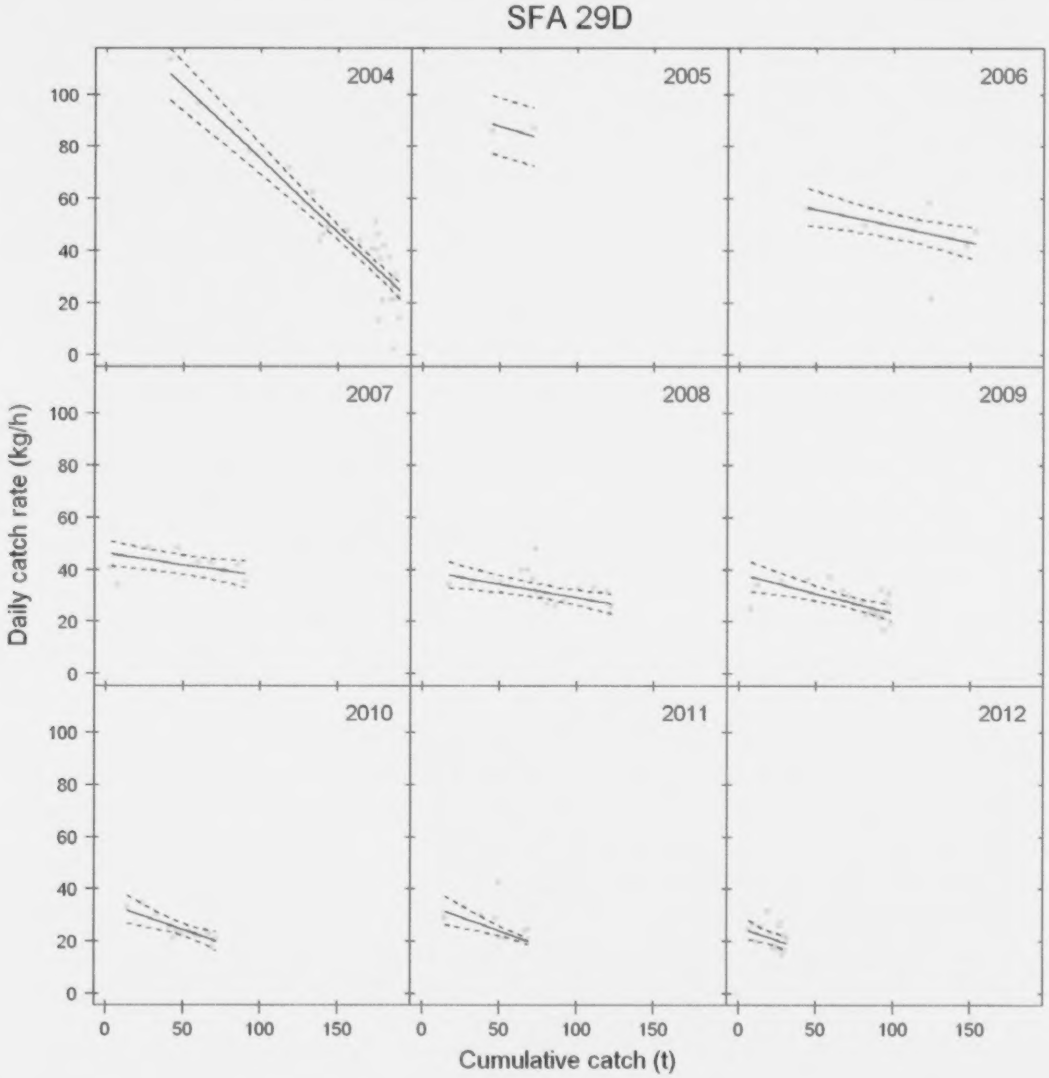

Figure 27. Depletion plots showing daily catch rates (kg/h) versus cumulative catch (t) and the Leslie model fit (with 95% CI) for SFA 29 West subarea D (2004–2012).

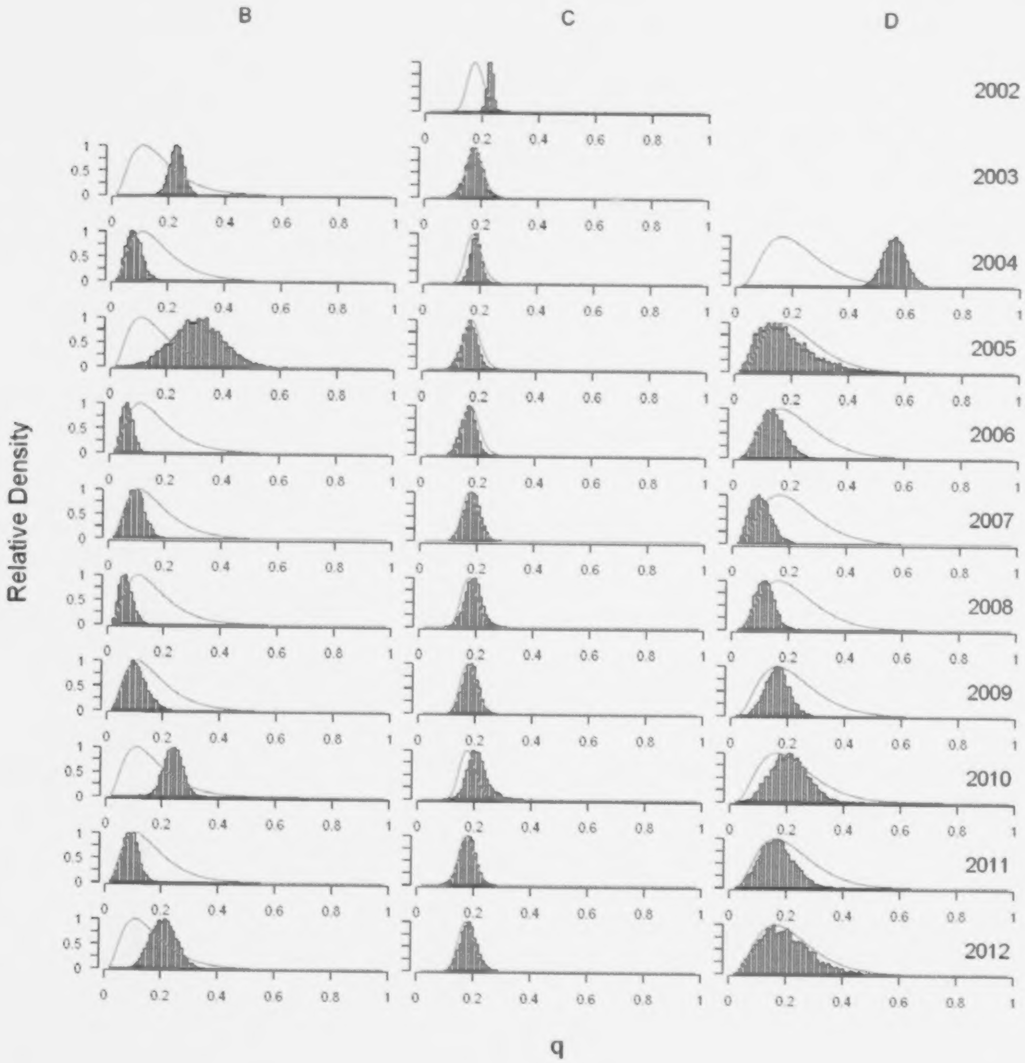

Figure 28. Posterior distributions of the catchability coefficient for SFA 29 West by subareas B to D (2002–2012). The red line is the prior for q shared among years.

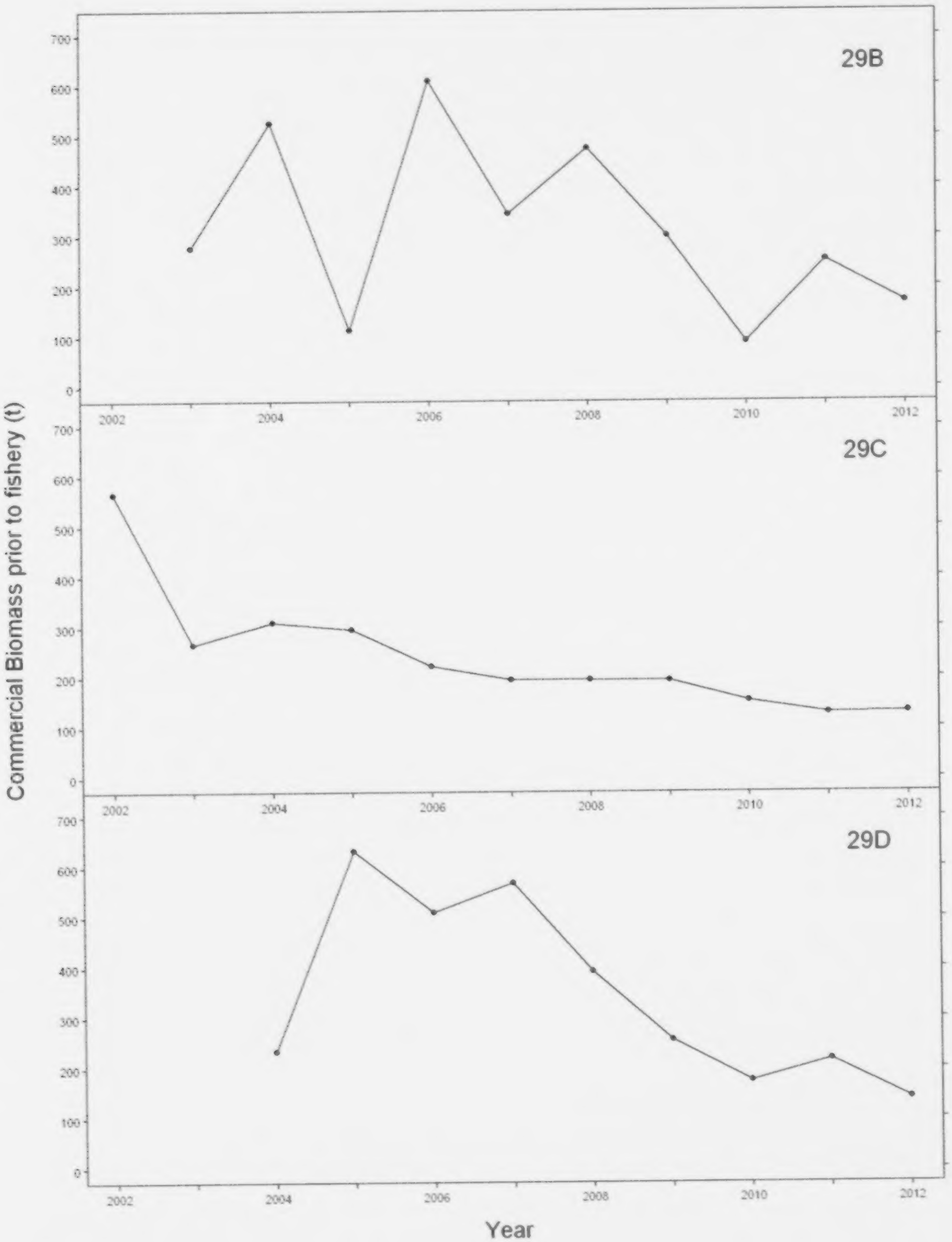

Figure 29. Median estimates of the initial population biomass (t) for SFA 29 West subareas B to D from depletion estimates (2002–2012). The initial population represents only the area fished in a given year.

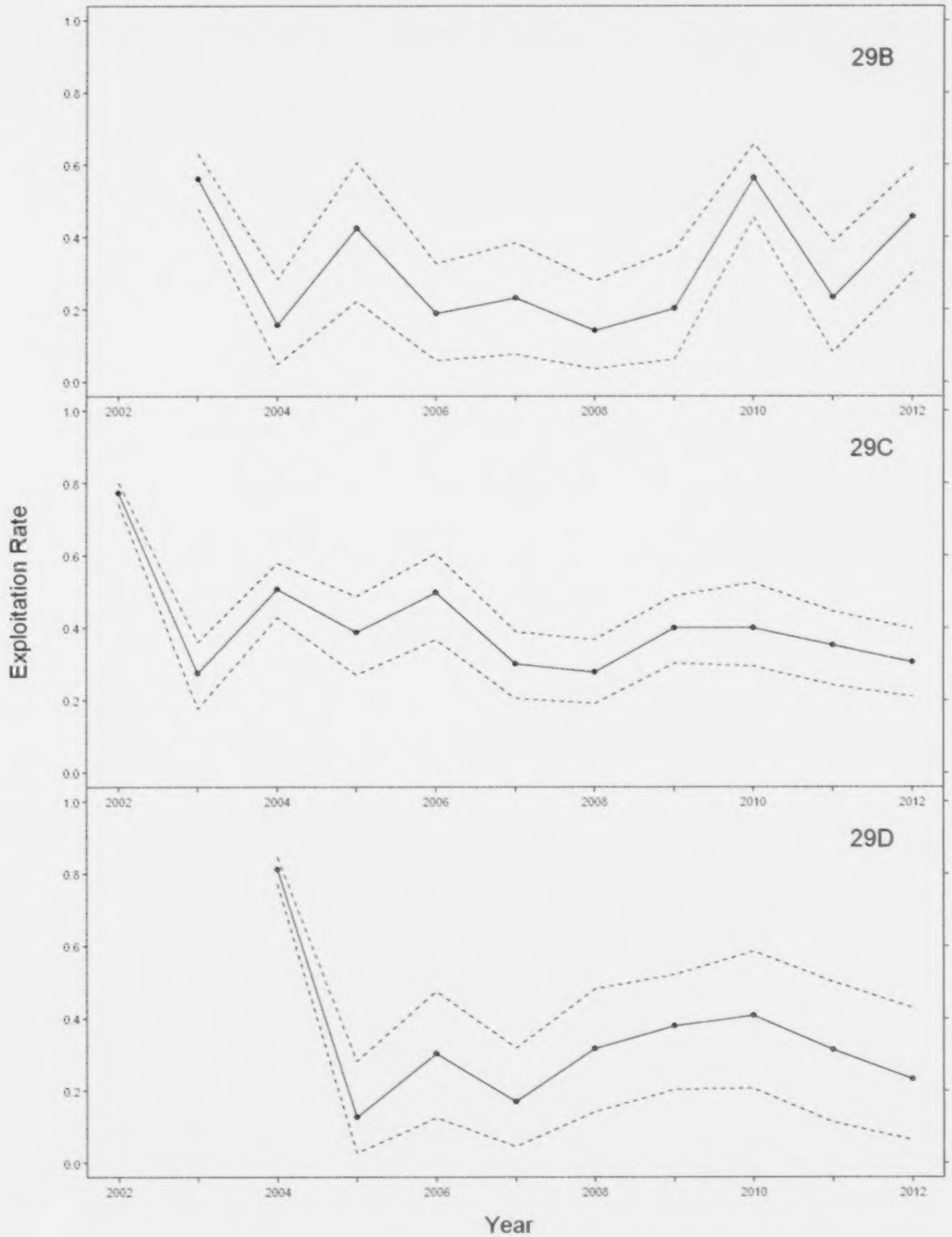

Figure 30. Median estimates of the exploitation with 95% CI for SFA 29 West subareas B to D from depletion estimates (2002–2012).

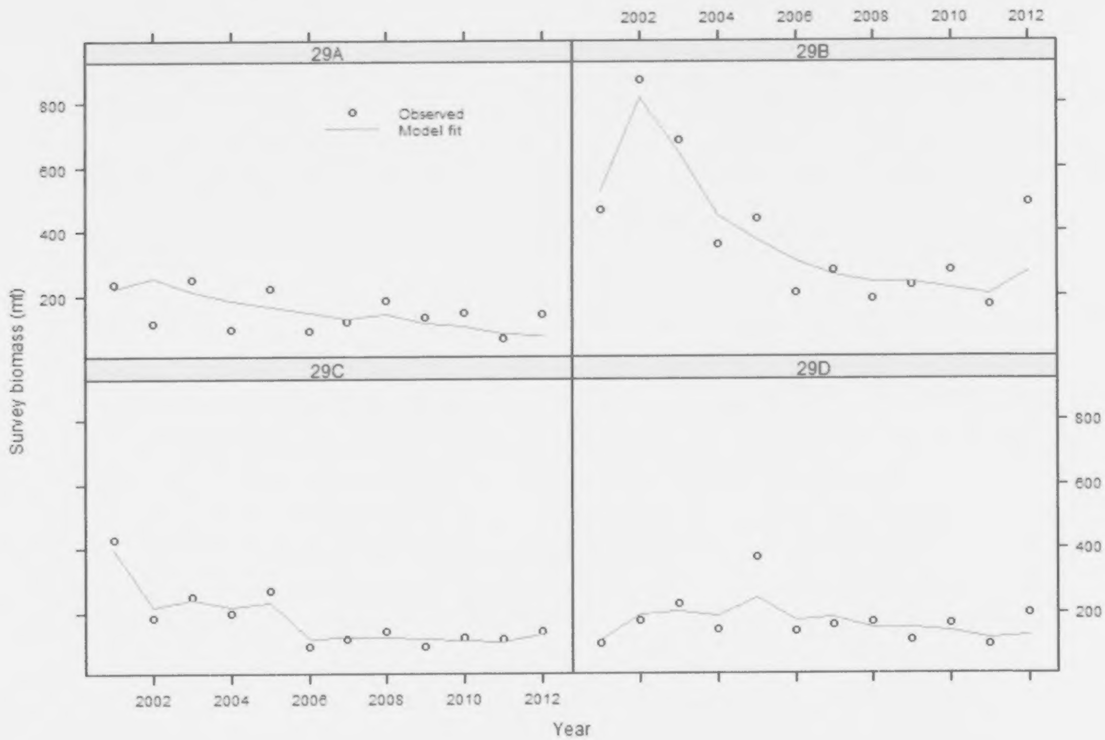

Figure 31. Fit of the survey biomass model (t) to the observed survey estimates of the biomass of commercial size scallops in SFA 29 West by subareas A to D (2001–2012).

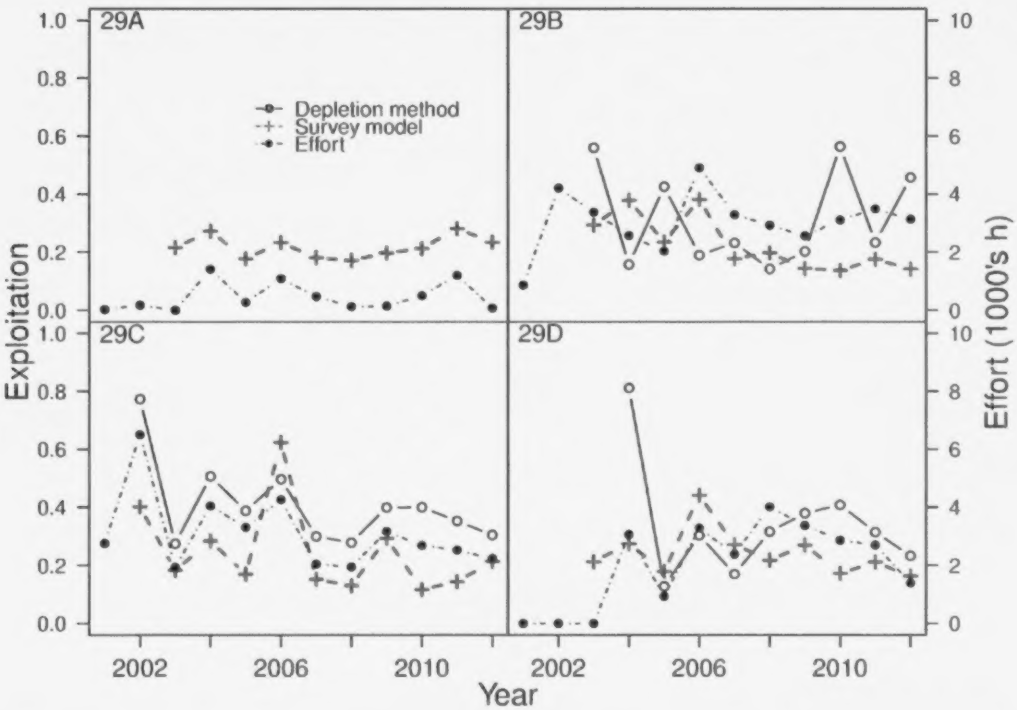

Figure 32. Comparison of exploitation estimates from the depletion method, survey biomass model and the total annual fishing effort for commercial size scallops in SFA 29 West, subareas A to D (2001–2012). Note that reliable estimates of exploitation for subarea A were not obtained from the depletion method.

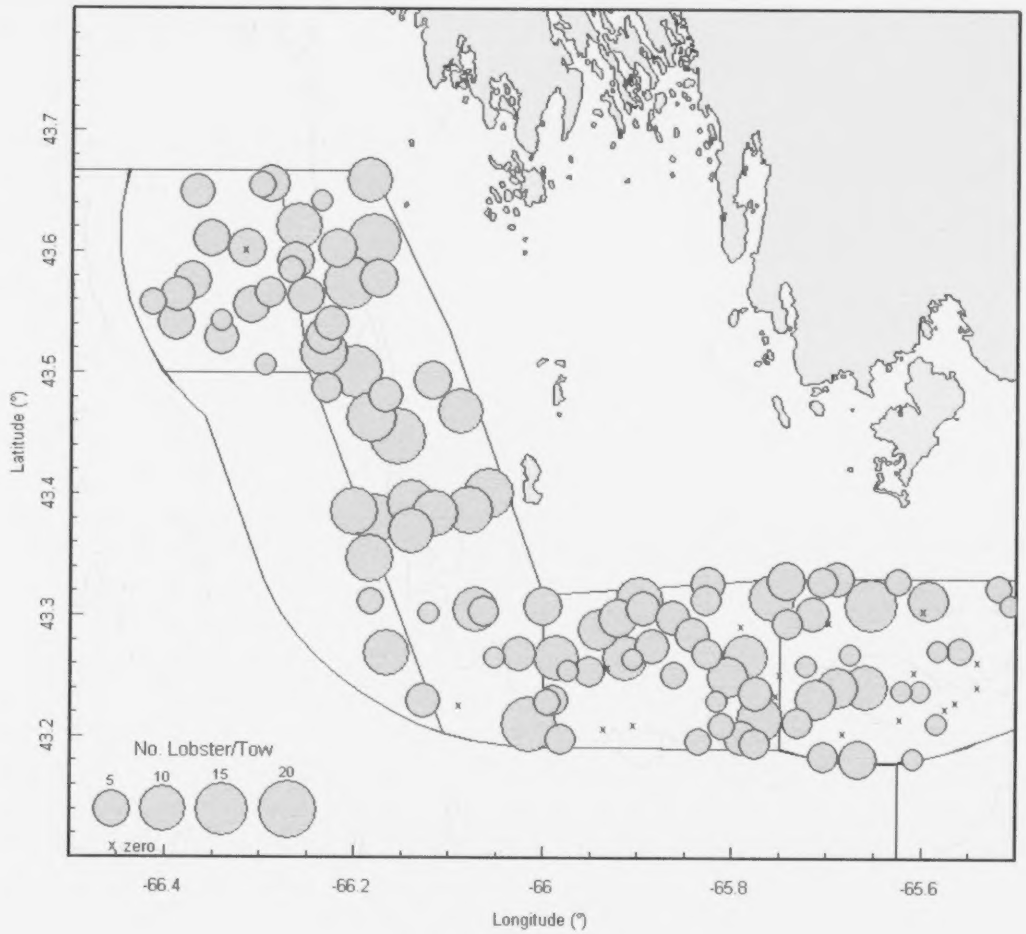

Figure 33. Location and number of lobsters caught in SFA 29 West during the 2012 survey. Crosses indicate locations where no lobsters were caught.

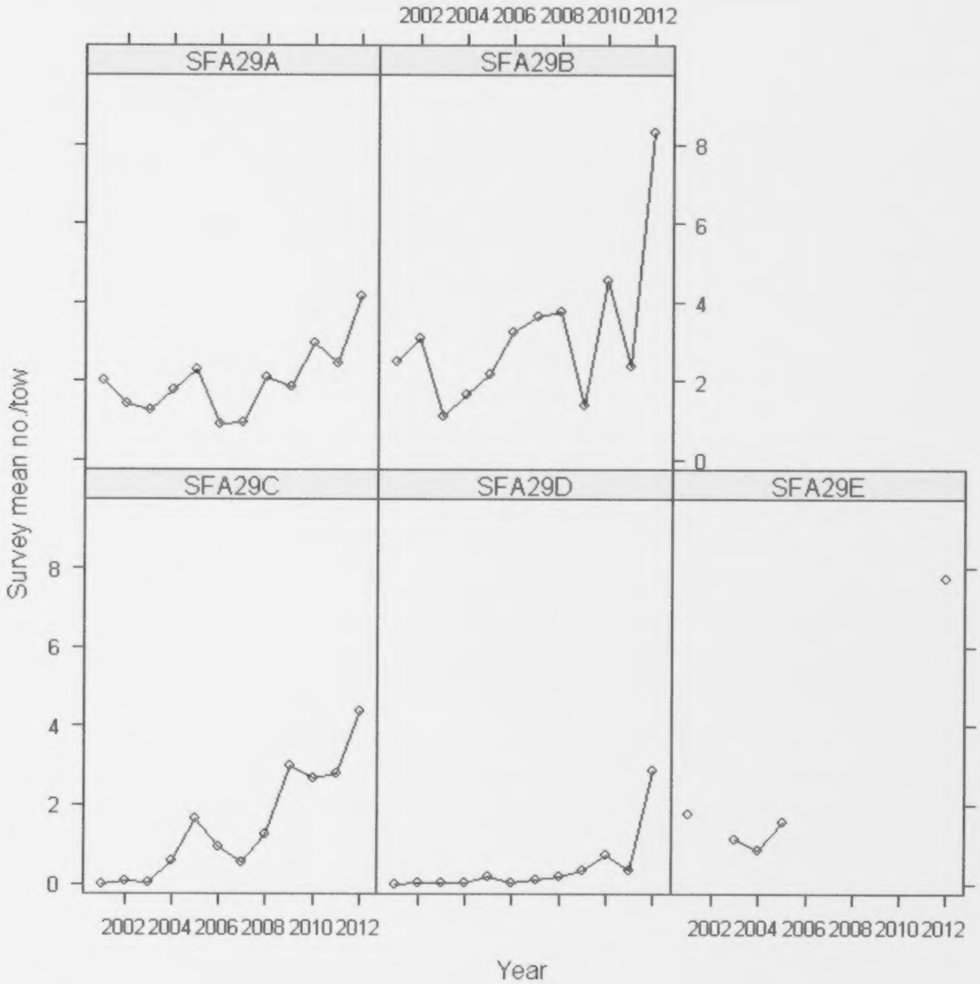

Figure 34. Lobster number per tow from scallop surveys in SFA 29 West (2001–2012). Subarea E is not routinely included in the survey. Geophysical strata used for design.

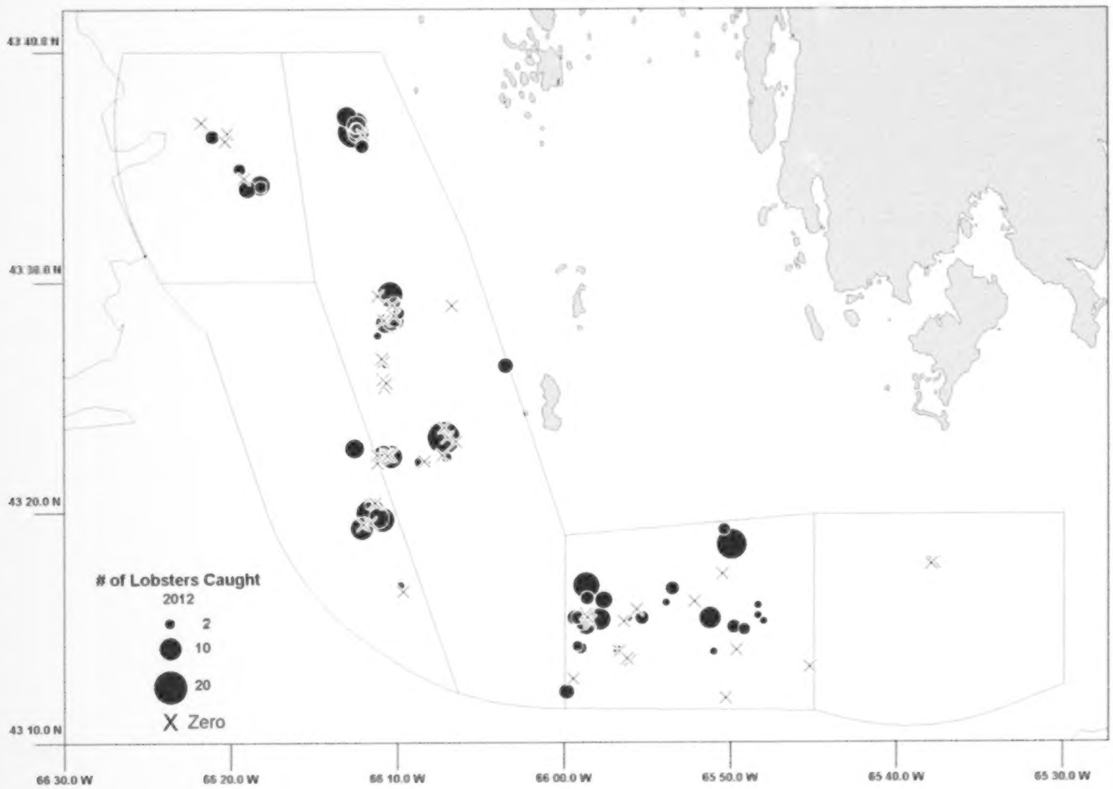

Figure 35. Location and number of lobsters caught in SFA 29 West in 2012 from observed scallop fishing trips. Crosses indicate locations where no lobsters were captured.